TERRA

THE NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

VOL. 22, NO. 3 • JANUARY/FEBRUARY 1984

FROM THE DIRECTOR

Dr. Craig C. Black

After my first year with the museum it is appropriate to look back and to assess what has been accomplished as well as to look forward to the opportunities ahead. The past year has been a full and exciting one for me and, I believe, it has been one of solid accomplishment for the museum.

It became clear early last fall that the Natural History Museum of Los Angeles County is a very complex institution and that learning its intricacies would take time and reflection. This process of assimilation should now be complete and I can enter a new year with, on my part, a knowledge of the museum, its staff, its Boards, and its many supporters and volunteers and, on their part, with an understanding of my aspirations and priorities.

The museum has great resources and an almost unlimited opportunity for service to the southern California community. During the past year the Board has approved a program plan which stresses three objectives for the coming years. These are: (1) completion of the American Indian Hall, (2) completion of the Dinosaur Hall, and (3) strengthening the general operation of the Foundation through meeting the National Endowment for the Humanities Challenge Grant and enhanced ongoing participation in the Business Associates and Museum Fellows programs.

These objectives are challenging ones and their successful conclusion will require a strong and concerted effort on the part of all Board members, our membership, and the staff. Our goal is to raise $10 million to see these projects fulfilled.

As I reflect on this past year, I am tremendously heartened by the progress we have made and I firmly believe that our goals are both reasonable and attainable. The County Board of Supervisors, in a very tight financial year, approved our operating budget at a slightly higher level for 1983–84 than we had in 1982–83. This support is important and it provides recognition that the museum is of significance and that it is a vital part of County service to this community. The Museum Foundation has also made a strong financial commitment to the museum approving a 1983–84 operating budget of $1,400,000. These two factors will allow us to provide additional staff in History, Anthropology, and some areas of the Life Sciences.

During the past year we received strong support from both the National Science Foundation and the National Endowment for the Humanities. The initial phase of the renovation of storage for our fish and herpetological collections was completed and these two nationally important collections and their staff should be totally moved into new storage and offices this year. To date we have raised over $500,000 to meet the Humanities Challenge Grant including a sizable gift from the Seaver Institute for programs in Western History. This year we must raise an additional $750,000 to meet the Challenge Grant requirements.

Late in the summer we began a major effort to increase our membership. While our annual attendance for the two museums is near 1,500,000, our membership is woefully low, standing at 8,400 in July. Through a direct mail campaign and a drive for current members to give gift memberships in the museum we expect to raise membership to 12,000 this next year.

Finally, we made some significant strides in enhancing our exhibition program during the past year, most notably with the Jim Gary Dinosaur Exhibition. This year we will open three history exhibitions especially tailored to coincide with the Olympics. The museum will also complete its last permanent history hall, the Seaver Hall of American History 1815–1865, scheduled to open in late May of 1984.

Our past year has been a good one; the coming year should be an excellent one.

CURATORS & COLLECTIONS

Invertebrate Fossil Collections Added to Museum

In September of 1983, the California Institute of Technology and the University of Southern California completed transfer of large collections of invertebrate fossils to the Museum in independent transactions. Preliminary estimates suggest that the collections may contain in

(Continued on page 30)

TERRA

THE MEMBERS' MAGAZINE
OF THE NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY
AND THE PAGE MUSEUM
OF LA BREA DISCOVERIES

VOL. 22, NO. 3 • JANUARY/FEBRUARY 1984

CONTENTS

THE NAMING OF GEMS
by Bill Boyajian 3

IN SEARCH OF FOSSIL PLANTS
by David Dilcher 10

THE CALIFORNIA CONDOR: LIFE ON A SLENDER THREAD
by Lloyd Kiff 16

BIRDS AND ELECTRICAL ENERGY PRODUCTION: DO THEY MIX?
by Elizabeth Anne Schreiber and Ralph W. Schreiber 20

BOOK REVIEW
by Camm C. Swift 23

CELEBRATIONS OF THE INSECT FORM: WATERCOLORS BY RAY BINGHAM 24

COVER

Amethyst mineral specimen—longest dimension 8¼". Amethyst goblet 4½" high. Faceted heart 32 carats. Carving 18 carats. Courtesy of Pala International, Inc. Photograph by Harold and Erica Van Pelt.

EDITOR
Robin A. Simpson

ASSOCIATE EDITOR
Harry J. Pack

ASSISTANT EDITOR
Leslie L. Wilson

DESIGN
Armin Krumbach

EDITORIAL BOARD
Judy H. Astone/Craig C. Black/Alexander P. Butterfield/Greg P. Byrd/Daniel M. Cohen/John M. Harris/Harry Kelsey/Richard Lipscomb/Denise J. Martin/William A. Mingst/Harry J. Pack/Robin A. Simpson

MUSEUM PHOTOGRAPHERS
Dick Meier/John DeLeon

MUSEUM ILLUSTRATORS
Mary Butler/Joseph Nakanishi

Printed by North Hollywood Printing Co., Inc.
Color separations by Graphic Arts Systems
Typography by R S Typographics

All Rights Reserved. Reproduction in whole or in part without permission is prohibited.

ISSN 0040-3733

THE NAMING OF GEMS

by BILL BOYAJIAN

The naming of gems is a process combining science and fable. Gems are named for their appearance, their physical attributes, the sites where they were discovered, and the myths that surround them; some gem names are selected to honor certain people. Gem names often seem to have been derived arbitrarily, but when their roots are investigated, the names are usually quite appropriate in some sense.

AMBER. Although the meaning of the Arabic word "anbar," from which we get the English name for this gem, is not known, other names for the gem reflect its unusual qualities. Amber burns readily, emitting a sweet, resinous odor, and has from time to time been used as incense. The German name for the gem is bernstein, which means "stone that burns." When amber is rubbed it develops a static electric charge, enabling it to pick up tiny bits of dust. The ancient Greeks noted this property and called amber "electron." The Greeks also apparently believed that amber was solidified sunshine that floated in from the sea, where the solidification occurred when pieces of the sun were broken off as it sank into the west.

ANDALUSITE. Although Brazil and Ceylon are the major producers of andalusite today, the stone was first discovered in the Spanish province of Andalusia, from which it derives its name. Andalusite has been nicknamed "poor man's alexandrite" because of its resemblance to the rare alexandrite chrysoberyl.

BERYL. Beryl derives its name from the ancient Greek word for gem, "berullos," which in ancient times probably referred to any gemstone. Aquamarine, emerald, and morganite are varieties of beryl.

Aquamarine derives its name from the Latin words for sea water ("aqua marina") in reference to its greenish-blue color.

The word "emerald" is derived indirectly from the Greek word "smaragdos," which means green stone and was probably used at one time to refer to all green stones. Over the centuries, "smaragdos" evolved to the old French form "emeraude," which is the basis of the English spelling. An emerald was traded as early as 4000 B.C. in Babylon, in the earliest known gem market. Since green is a very soothing color to the eye, the Emperor Nero supposedly refreshed his eyes while viewing the violence of the gladiators by looking through a lens made of fine emerald. (Because of the nature of gem identification talent in Nero's time, there is serious question as to the validity of this legend!)

Morganite, the beautiful pink variety of beryl, is named after the American financier, J. P. Morgan, in recognition of his contribution to gemology and mineralogy in presenting his magnificent gem collection to the American Museum of Natural History.

ANDALUSITE

MORGANITE

AQUAMARINE

EMERALD

CHRYSOBERYL. This mineral was once thought to be a variety of beryl, and its name comes from the Greek words for golden beryl ("chrysos berullos").

Alexandrite, a variety of chrysoberyl, is one of the most cherished stones in all of the gem kingdom. It was named in honor of Czar Alexander II because it was thought to have been discovered in Russia on his birthday in 1830. The change of color in very fine stones of alexandrite—from green in daylight to red in artificial incandescent light—is an amazing and delightful characteristic of this gemstone.

ALEXANDRITE (DAYLIGHT)

ALEXANDRITE (INCANDESCENT LIGHT)

CORUNDUM. This word comes from the old Tamil word "kurundam," which may have come from the Sanskrit "kuruvinda," meaning ruby. Ruby and sapphire are varieties of corundum.

"The price of wisdom is above rubies," said Job, who believed that wisdom is man's most precious gift from God. The name "ruby" is derived from the Latin word for red ("rubeus") in reference to its color. Many people believed that colorless sapphires were unripe rubies and that these stones would eventually mature to a red color. Others believed that highly flawed stones were "over ripe" and concluded that the color of ruby deepens as the stone ripens. Today there is a theory that the chromium that gives the ruby its color also causes a greater breakdown in the crystal structure than the color-causing oxides of the various colors of sapphire. Hence, rubies—particularly those of deeper colors of red—are often more highly flawed than other varieties of corundum.

The sapphire takes its name from the Greek word for blue ("sapphieiros") in reference to the most commonly assumed color of this variety of corundum. Today, the word is used to refer to all colors of corundum except red, but when the term "sapphire" is used without a color prefix, it generally refers to the blue variety. The term was once understood to also mean what is now called "lapis lazuli."

Star sapphire is called the "stone of destiny," and the three bands that form the star are said to represent faith, hope, and love.

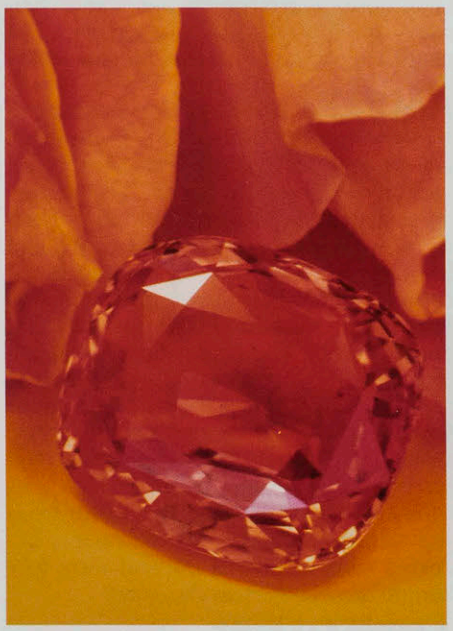
The Kashmir sapphire is named after Kashmir, India, which is high in the Himalayas and has historically produced the finest, most desired sapphires (this area has produced sapphires since 1880 and may very well be worked out today). Kashmir sapphires are a deep blue with a subtle velvety appearance, probably caused by submicroscopic particles evenly dispersed throughout the stone.

Padparadscha, the rarest and most desirable fancy sapphire, takes its name from the Singhalese word for lotus flower, because the gem has a similar pinkish-orange color.

Though many legends and superstitions have been ascribed to sapphire throughout time, perhaps the one most suited to today's society is that sapphire will preserve the wearer from jealousy.

RUBY

KASHMIR SAPPHIRE



PADPARADSCHA SAPPHIRE

MOONSTONE

DIAMOND. The diamond was named "the unconquerable" by the Greeks because of its unparalleled "hardness," or resistance to scratching (the Greek root is "adamas," from which we get our modern word "adamant").

FELDSPAR. This mineral takes its name from the Old German words for referring to any easily cleavable mineral found in fields.

Moonstone is a convenient and descriptive term for feldspar stones with adularescence — a changeable billowy light appearance caused by internal reflections. The phenomenon is named after the Adula Mountains of the Swiss Alps, an early source of moonstones. Bluish adularescence is much more attractive and valuable than the white form.

As one might imagine, many superstitions are associated with moonstone. The stone is thought to bring good fortune, and a person is said to be capable of predicting the future if a moonstone is placed in the mouth. The stone is also rumored to arouse tender passions of love.

ALMANDITE

GARNET. This gemstone was named after the pomegranate (medieval Latin "granatum," or "having many seeds") because garnet crystals in rock reminded early scientists of the shape and color of pomegranate seeds.

Almandite garnet derives its name from the Latin word "alabandina" in reference to the town of Alabanda in Asia Minor where garnets were found in ancient times.

Demantoid, the garnet that is one of the most sought after stones of all in the gem kingdom, was first found in Russia in 1868. Its name is derived from the German word for diamond ("demant") and refers to this gemstone's high dispersion and luster.

Rhodolite, another garnet, takes its name from the Greek words "rhodo" and "lithos," meaning rose-colored stone. The gem is sometimes referred to as the "rhododendron" garnet because of its likeness to the flower of that name. Garnet species often readily mix with one another, and it is not surprising to learn that rhodolite is composed of approximately two parts pyrope, a dark red garnet, and one part almandite, which is usually a dark brownish-red. The surprise is that the combining of garnets of these hues and tones results in the rich violet color of rhodolite.

Tsavorite, the beautiful green garnet discovered in 1967, was named by Tiffany and Company for the area in which it is found, the Tsavo National Park in Kenya, East Africa.

Asiatic peoples used red garnets as bullets, believing that their color would cause them to inflict a more deadly wound. This use of garnet has also been noted in several accounts of United States Indian Wars.

MALAYA GARNET

JADE. "Jade" is the common name for two similar minerals — nephrite and jadeite. The term originated from the spanish "piedra de ijada," which means loin stone. Jade supposedly relieved pain from kidney ailments if applied to the side of the body. The Spanish term was later translated into French and was subsequently simplified in English to "jade."

The word "jadeite" was coined in 1863, when the difference between nephrite and jadeite was first discovered. Since that time, jadeite has been found to be second among gems only to nephrite in "toughness" (resistance to breaking, chipping, or cracking).

The term "Imperial jade" apparently emerged when the Imperial Court of China preferred a fine jadeite to a host of exquisite gifts that had been presented to the Court, and this term has long been associated with the finest qualities in green jade.

JADEITE

LAPIS LAZULI. This is a blue, opaque rock found in finest quality in Afghanistan. "Lapis" means stone in Latin; "lazuli" comes from the Latin "lazur," which means "blue as the clear sky."

MALACHITE. Malachite, according to one theory, derives its name from the Greek word for mallow ("malache") because its color is similar to that of the leaf of this plant. Another theory is that the name is based on the Greek word for soft ("malakos") in reference to the fact that malachite is a very soft copper carbonate. Because the banded structure of malachite often suggests the form of an eye, malachite was worn in some parts of Italy as an amulet to protect the wearer from the spell of the "evil eye."

OPAL. The name of this gem traces back to the Sanskrit word "upalas," meaning precious stone. To the ancient Romans, opal was "cupid stone," or "stone of the child as beautiful as love."

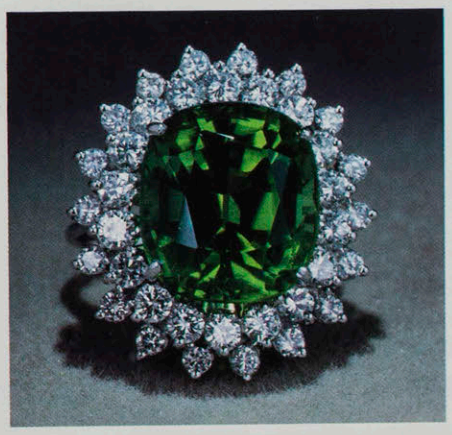
The superstition that opal is an unlucky stone may have begun in the middle of the 19th century, when Sir Walter Scott's novel, *Anne of Gierstein*, enjoyed some popularity. The heroine of the book owned an opal that reflected her every mood, flashing red when she was angry and turning gray as she was dying. Some people claim that bad luck became associated with opal before Scott's novel, perhaps as early as the seventeenth century, on the basis of a Teutonic superstition. It does seem more probable that Scott drew upon an already existing belief about the opal rather than that his fiction came to be taken as fact by so many people. A more practical explanation of the opal's reputation of unluckiness relates to the fact that it is a hydrous silicate that may dry out, possibly causing surface cracks.

PERIDOT. This gem takes its name from the Old French "peritot," the meaning of which is uncertain. Peridot is known by American mineralogists as "olivine" and by German mineralogists as "chrysolite." Since the term "peridot" leads to no confusion, it is the preferred name for this stone. Peridot has misleadingly been called "evening emerald," because it is said that its subdued loveliness often looks best at night.

LAPIS LAZULI

MALACHITE

OPAL



PERIDOT

JADEITE

Page 6: Natural green jadeite earrings 25mm. in diameter courtesy of the Crystalite Corporation. Photograph © 1981 Harold and Erica Van Pelt.

AMETHYST

SMOKEY QUARTZ

ROCK CRYSTAL QUARTZ

QUARTZ.

"Quartz" comes from an Old German mining term "quarz," which has been in general use in many languages since the sixteenth century but whose origin, like that of peridot, is obscure.

Amethyst, a variety of quartz, takes its name from the Greek word "amethustos," which means "not to intoxicate." The ancients believed that the stone had the power to prevent drunkenness and drank from mugs carved of amethyst. They also believed that amethyst would quiet the overpowering excitement of love passions.

Rock crystal derives its name from the Greek word meaning clear ice ("krustallos") because the Greeks believed that this mineral was ice in permanent, solidified form. Quartz was one of the first gemstones to be used by man. In fact, the original crystal ball was no doubt a ground and polished rock crystal quartz rather than a molded, man-made glass ball. Examination of an authentic rock crystal gazing ball, such as the one on display in the Gem and Mineral Hall, at the Natural History Museum provides doubled images, proving that the material is not glass. Today, because of its piezoelectric effect (ability to assume an electrical charge when stressed in certain directions), quartz has many commercial uses—as oscillators in watches, in measuring and controlling frequencies of radio waves, and for underwater signaling and submarine detection, to name just a few.

Brown quartz, which is perhaps most appropriately called smoky quartz in reference to its color, was originally called cairngorm after the Cairngorm Mountains of Scotland, one of its classic sources.

CITRINE

SPINEL.

The derivation of the word "spinel" is unknown. Perhaps the name is derived from the Latin word "spina," which means thorn, in reference to its sharply pointed octahedral crystals. Another theory holds that the name comes from the Greek word for spark and refers to the red or orange-red color of some spinel crystals. Misleading terms such as "balas ruby" (derived from Balascia, a region in northern India where the spinel is found) and "spinel ruby" have no doubt fostered confusion and hindered the popularity of this beautiful gemstone.

The highly lustrous, near perfect octahedral crystals of spinel that are found in Burma have been given a name there that means "spinels that have been cut and polished by spirits."

SPODUMENE.

Spodumene was named before the gem variety of the mineral was discovered; the name comes from the Greek word "spodoumenos," meaning burnt to ashes, and refers to the ashy color of crude nongem crystals of this mineral.

Kunzite, a beautiful pink variety of spodumene, was named after George Frederick Kunz, an American mineralogist and gem expert of Tiffany and Company, who first described the stone in 1902.

SPINEL

KUNZITE

TANZANITE. This mineral was discovered in 1967 and named by Tiffany and Company after the East African country of Tanzania, where it is found.

TOPAZ. Topaz is another common gemstone with a name of uncertain derivation. One theory holds that "topaz" comes from the Sanskrit word "tapas," which means fire. It is more likely that the stone is named after an island in the Red Sea where the gem was supposedly found; in ancient times, the island was known as Topazios, a name taken from the Greek word meaning "to seek" ("topazo") because it was often obscured by fog and difficult for navigators to find. This island is apparently what we now call St. John's Island, a classic source of peridot. This leads one to believe that our modern day peridot was in ancient times called topaz.

TOURMALINE. This gemstone takes its name from the ancient Singhalese word "turamali," which means "mixed precious stones" and reflects the fact that tourmalines were often confused with other gemstones. The name is even more appropriate today because we now know that tourmaline has one of the most complex chemical compositions of all gem materials and thus occurs in a wider range of colors than any other gem.

It is said that Singhalese gem merchants originally used the name "turamali" to refer to yellow zircons and that it may have come to have its current meaning when a package of tourmaline was sent to Amsterdam in 1703 mistakenly labeled "turamali." There is no doubt that the variation of color tones and hues of tourmaline has fostered problems historically that are exceedingly difficult to explain even today.

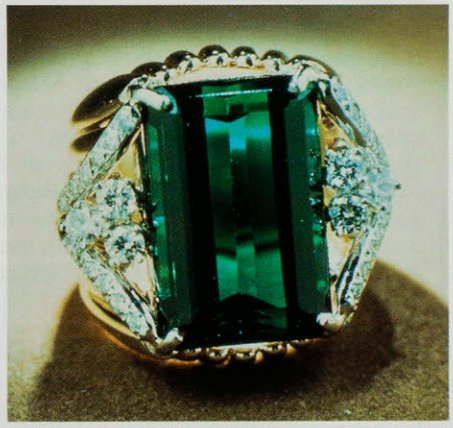
Rubellite (red tourmaline), like ruby, takes its name from the Latin word for red. Indicolite (blue tourmaline) is named because its color is sometimes close to indigo.

The Dutch, who first imported tourmaline to Europe, knew of its property of pyroelectricity (when rubbed or heated, a tourmaline crystal becomes electrically charged and will attract dust particles and other very light debris). The Dutch used tourmaline to clean ashes out of their pipes and called the gemstone "ash-puller." Green tourmaline was at first called "Brazilian emerald" until it was noticed that crystals warmed by the sun would attract or repel ashes and straw.

Another property of tourmaline that is attributable to its polarity is piezoelectricity. Tourmaline plates have been used in depth gauges for underwater craft and require no man-induced electrical charge.

TANZANITE

TOPAZ



TOURMALINE

TOURMALINE

TURQUOISE

TURQUOISE. The word "turquoise" was apparently first used in the thirteenth century and is thought to have come from the French word for "Turkish" ("turquois"), probably because the gemstone first reached Europe by way of Turkey. The Persian word for turquoise means victorious, and turquoise is highly prized by many Middle Eastern peoples. Turquoise was used in the oldest piece of jewelry yet discovered, a bracelet found on the arm of the mummy of an Egyptian queen. This jewelry piece is estimated to be some 7,500 years old, yet the turquoise pieces are still beautiful.

Bill Boyajian, Graduate Gemologist, is Manager of New Product Development for the Gemological Institute of America. For the past 4 years, he has supervised the colored stone and gem identification classes of the GIA's Resident Gemology Program. He has also conducted seminars and classes on gemology throughout the United States and in Japan.

Photographs on pages 3 through 5 and 7 through 9 by Tino Hammid and Mike Havstad; courtesy of Gemological Institute of America.

IN SEARCH OF FOSSIL PLANTS

by DAVID DILCHER

The excitement of new discovery is always with the paleobotanist as he sets out in search of fossil plants. Each new field site has the potential to yield the fossils needed to better answer the questions we ask about ancient, extinct forms of life. How does the paleontologist know where to look for fossils, and how does he determine the age of the fossils that he collects? These are questions I am most frequently asked about my field work. They are good questions and deserve answering.

Plant fossils are usually discovered in sedimentary rocks, which most often preserve plants as compressions, impressions, or petrified remains. Plants, unlike animals, shed many of their organs. Leaves, cones, unfertilized flowers, and fruits and seeds fall from trees at various times during the year. They are often carried by wind or water into rivers, lakes, or swamps, where they become buried in water-borne sediments, which eventually harden into sedimentary rock. Leaves, flowers, fruits and seeds, stems and roots have all been found preserved as fossils in many parts of the world.

The actual discovery of fossil plants can occasionally be serendipitous. During a walk down a weathered canyon a petrified tree trunk might be discovered; turning over a rock might expose a leaf impression. Such chance and lucky finds of fossils were not uncommon over 100 years ago as the Wild West opened to settlement. Fossil stumps, abundant plant impressions, and bones of extinct animals that had been undisturbed for hundreds, even thousands, of years were often found strewn about as the rocks weathered away from them. Many exposed fossils were collected by professionals and amateurs and ended up in museums, universities, and private collections; a few, such as those at Petrified Forest National Monument in Arizona, still remain where they were originally exposed. Because of the number of people that have scouted many of the fossil-rich areas in the West over the past century, fossils are less likely to be found exposed on the surface now. But many fossils are still buried, waiting to be exposed by nature or by man.

As North America continues to become more populated and developed, more fossil sites are found and reported by hikers traversing remote valleys of our national wilderness areas, as well as by engineers and laborers at mining and construction sites. I learned of several fossil plant-bearing clay pits of Eocene age in Kentucky and Tennessee when I visited the mining offices of clay companies and asked if they had noticed any plant fossils associated with the clays being mined. In subsequent trips to these clay pits, I found some of the most spectacular flowering plant fossils — including leaves, fruits, and flowers—known in the world. Delicate flowers with many parts preserved, including petals and pollen as well as leaves with cuticle still intact after 45 million years, can commonly be found in the pits.

Some very good fossil plant localities have been discovered as a result of conversations and correspondence with colleagues who have shared their knowledge with me. I located an excellent area in western Colorado containing abundant fossil leaves, fruits, and insects from the Green River Formation in this way. During one of several visits to this area I found a site in which the fossil-bearing shales had been dug out and piled up, exposing large slabs of shale that could easily be split open. The slabs contained beautiful leaves — some attached to stems that also bore fruits—as well as insects and feathers.

A phone call one day from a colleague, Lance Erikson, a vertebrate paleontologist at the Museum of Western Colorado, resulted in a field trip to collect some of the most ancient fruiting material of flowering plants known in the world. These exceptionally well-preserved fruits are of an extinct flowering plant similar to the sycamore tree that lived when dinosaurs roamed the earth.

The development of geology as an organized science encouraged the detailed reporting of fossil-rich beds. Geologists have walked and mapped thousands of miles of creeks, rivers, and ocean coasts, examining exposures containing sedimentary rocks. They carefully note the type of rocks and fossils that they find inside these exposures. By reading geology reports and checking maps, I discover the location of particular sedimentary rock types likely to contain fossil plants — such as shales associated with seams of coal. Sometimes, reading old reports of fossil plant localities mined

out long ago can lead me to areas in which new exposures may have been opened up more recently. Searching through old geology reports and maps and walking outcrops in search of a good bed of fossil plants takes a great deal of time and effort, but the rewards can be well worth the work.

I found one fossil locality—the Braun Ranch area—through just such library research and searching in the field. I had read through the detailed descriptions of a Kansas geological report that had been produced in conjunction with a Conservation Corps Commission project back in the 1930s. Crews of men had been employed to dig pits or trenches in north-central Kansas, where few, if any, natural outcrops of sedimentary rocks occur. The geologist working with the project followed along behind the crews and described the clays, sands, and sandstones exposed in the pits. He wrote a report of the clays uncovered and included a few brief mentions of plant remains found associated with the clays.

I scouted each area that had been mentioned as containing plant fossils or leaf remains and spent several days driving the dusty backroads of Kansas to locate potential collecting sites. One locality was owned by a Mr. Braun, so Charles Beeker, a graduate student, and I stopped at his ranch to ask permission to collect. He was most helpful; he directed us to an area where some clay had been dug several years before on his ranch and extended an invitation to dig for fossils. We made our way to the area Braun had described and, with picks and shovels and newspapers for wrapping fossils, proceeded under the barbed wire fence and over a hill. When we found clay exposed, we dug into it and uncovered slabs filled with leaves, fruits, and flowering plant reproductive material. We knew we had found "paydirt." We have continued to collect at this site over the past few years and have been fortunate to find several outstanding fossils there. We have found many leaf forms; some appear to be an extinct form similar to modern sycamore. We have also found fossil seed heads that are probably part of this 100 million-year-old extinct sycamore, which is only vaguely similar to a living species found in Laos and North Vietnam today. Small flower petals, small clusters of fruits, and insect remains have also been collected in these clays. From nearby clays we have been able to extract pollen of ancient ferns, conifers, and flowering plants. Some unique spores of possibly extinct aquatic ferns can be isolated by sieving the clay. These are ornate floating spores carried about by lake water 100 million years ago when dinosaurs swam and roamed among these plants and the major radiations of mammals and birds were about to begin.

Warren Kouach

The fossil spore of a possibly extinct aquatic fern that lived about 100 million years ago.

Another important locality, Rose Creek, was discovered in quite a different way. One day in December I received an excited letter from Howard Reynolds, a professor of biology at Fort Hays State University, Kansas, who had recently visited Lincoln, Nebraska. While there, he contacted a geologist, Dr. Roger Pabian, to inquire about Cretaceous age plant fossil localities. Dr. Pabian directed Prof. Reynolds to a particular clay pit—the Rose Creek site—along the major road that Reynolds would travel going home to Hays, Kansas.

Reynolds had scouted various localities in Kansas for me and knew that he had found good fossil plants at Rose Creek. His letter described well-preserved leaf forms he had found and mentioned the potential of collecting fossil flowers there also. He drew a detailed map of the locality, and I took this with me the next summer as I prepared to go into the field. On a very hot July 4th that year, I made my first collections from the Rose Creek locality. There we found the oldest, most complete flower in the world. That was an exciting and memorable Independence Day.

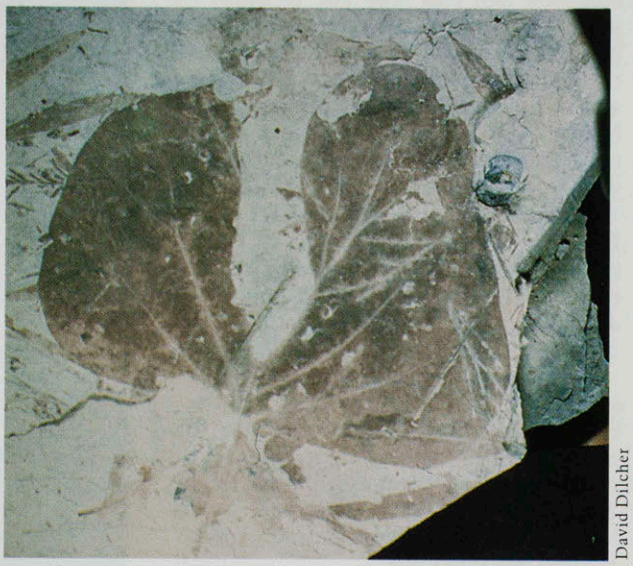
I learned of another locality by way of contacts made at a local rock club show in Bedford, Indiana. Dr. F. R. Turner, a colleague of mine in the Department of Biology at Indiana University, went to the annual rock club show and came home with several slabs of ironstone-like shale that were covered with impressions of flowering plant leaves and fruits. The shale material was described as being of Paleocene age; the fossils it contained were very interesting. Later Dr. Turner and his wife, Dr. Jocelyn Turner, drove out through North Dakota and collected a few more pieces. This gave us sufficient material for study, and a graduate student, Steven Manchester, and I published a paper on a particular extinct type of winged fruit. We have since collected other material from this locality that contained ginkgo leaves, birch-like leaves, maple-like winged fruits, alder-like seed-bearing axes, and a whole variety of angiosperm leaves.

How do I know the age of the fossil plants I've been collecting, and how is it possible to go to a particular layer of shale in the field and know the age of the shale? It is not difficult to determine the age of fossil plants to era or period, but it takes a great deal of detective work to place the age more precisely to epoch or stage. It is very easy when collecting fossil plants to become intrigued and enthusiastic about finds and to forget about determining their age until returning to the lab. However, the scientific value of specimens is directly related to the quality and amount of information about the collection site that is obtained. Thus, it is important to begin to learn as precisely as possible the age of the fossil plants while still in the field—the exact geographic location of the collecting site must be recorded, and the precise stratigraphic location of specimens within the sedimentary rocks must be mapped.

Fossil plants are not restricted to any one particular age of the earth's history. The Gunflint chert exposed along the north shore of Lake Superior contains some of the oldest known plants—re-

David Dilcher

Karl Longstreth, a laboratory assistant at Indiana University, removes a specimen of a flowering plant leaf from a 100 million year old clay deposit in Kansas.



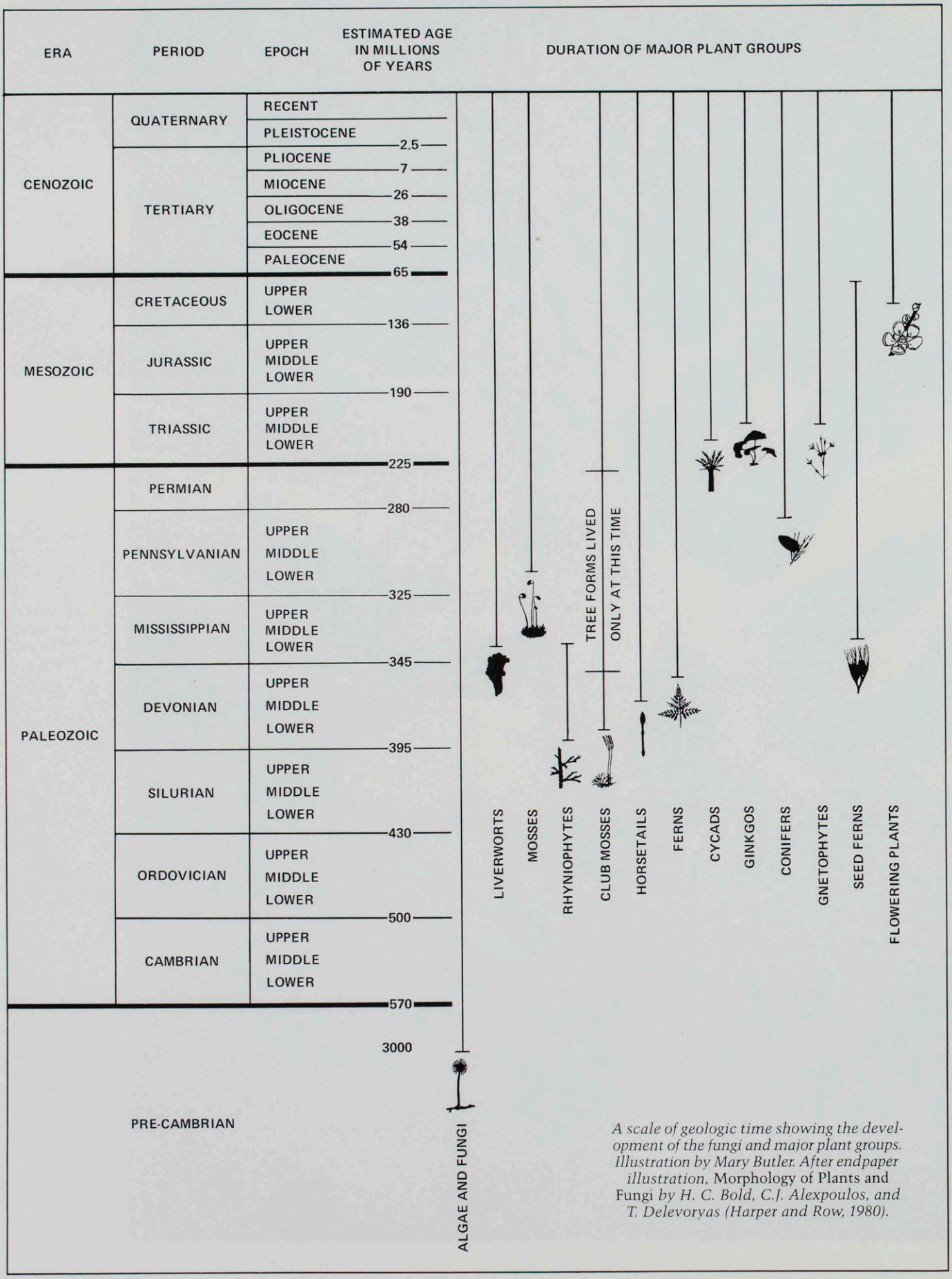
David Dilcher

A close-up view of the specimen. It is now on loan from Indiana University to Smithsonian Institution for exhibit in Washington, D.C.

A reconstruction of the leaf showing its form and veins. It is an extinct plant, and no living plant is known to have this type of leaf. Illustration by Megan Rohn.

A reconstruction of an entire reproductive branch of the plant. Illustration by Megan Rohn.

A stylistic concept of the plant in the landscape of Kansas about 100 million years ago. Illustration by Megan Rohn.



A scale of geologic time showing the development of the fungi and major plant groups. Illustration by Mary Butler. After endpaper illustration, Morphology of Plants and Fungi *by H. C. Bold, C.J. Alexpoulos, and T. Delevoryas (Harper and Row, 1980).*

mains of petrified algal cells dating from nearly 2 billion years ago. These cells are not the earliest evidence of life, but they represent some of the best preserved and best known early forms. Fossil plants are much more common in sediments deposited since about 400 million years ago, when the first vascular land plants developed. Most vascular land plants preserve more readily than algae, mushrooms, or mosses because they have a resistant, waxy cuticle that coats the surface of all the cells exposed to the atmosphere. This waxy layer keeps the cells from drying out and is also quite resistant to decay. The woody vascular tissue and the spores or pollen produced by land plants also tend to resist quick decomposition and are often preserved as fossils.

Because various organs of land plants—spores, pollen, seeds, fruits, leaves, and stems—are dispersed or break apart from the parent plants, whole plants are rarely found as fossils. However, through careful study, the plant species to which the disassociated organs belong can often be identified. This work of reconstructing whole plants from various fossil plant parts is not finished, but it is complete enough for us to know what many plants looked like and to realize that vascular land plants have changed a great deal in their form and mode of reproduction through time. By knowing what the earliest land plants are like and following their change through time, we have been able to develop lists of particular fossil plants that characterize each age. The earliest animals to live on land were the ancestors of modern insects and spiders, followed by amphibians, then reptiles, birds, and mammals. A progressive change in land plants through time — which is important in dating sedimentary rocks—can also be seen.

Early land plants had a rather simple organization and were small, reaching not more than the height of about 6 to 8 inches. These plants are all extinct, but through time, larger and more complex plants developed that have relatives living today. Small ferns were followed by tree-sized fern-like plants; small club mosses were succeeded by tree-size forms; and horse tails, seed plants, woody conifers, and finally flowering plants evolved one after the other.

Because the dominant types of land plants changed in a regular progression through time, we can estimate the general age of the sediments by examining the kinds of plants preserved in them. The later Paleozoic is a time of giant Lepidodendron trees (club moss trees) and calamitean trees (horse tails), while the Mesozoic is the age of ferns, cycads, and conifer trees. Certain less dominant plants have come and gone through time, leaving abundant and characteristic pollen or spores deposited in the sediments of each particular age. Flowering plants, first found about 125 million years ago, became abundant about 100 million years ago. Recognizable relatives of many modern families began to appear about 65 million years ago, and predominantly modern genera appeared only about 30 million years ago. Thus it is possible to use the evolution and modernization of plants, especially flowering plants, as a yardstick in world-wide time correlations of sedimentary rocks.

In the past, paleontologists have used invertebrate animal fossils to date marine sediments and vertebrate fossils to date terrestrial sediments. But now the use of fossil plants to estimate the age of terrestrial and marine sediments is developing into a very exact science. These methods of dating using fossils rely on the fact that certain types of plants and animals lived in the oceans or on land at one narrow time interval of a few tens of thousands or few million years over the vast billions of years of earth history. Both plant and animal fossils may be used together; for example, when new types of plant fossils are found associated with animal fossils in sedimentary beds, the animal fossils can be used to extend dates to the new types of fossil plants. The use of fossils to provide relative ages of the strata of sedimentary rocks is called biostratigraphy.

We know that dirt, sand, silt, clay, and weathered rock debris are carried into depositional basins of various sizes. Sedimentary cycles in large basins often repeat themselves over long periods of geologic time, resulting in the deposition of large amounts of weathered clay, silt, or sand, which often bury low-lying swamps or otherwise trap a variety of plant parts. The sediments on the bottom of a basin are the oldest; those near the top were the last to be deposited. This "superpositioning" has occurred all through earth history and is useful in determining relative ages of material from rock layers. Dating becomes more complicated when the sedimentary beds have been warped, bent, folded over, or broken so the older series of sediments are thrust over younger sediments. Such disruptions most often happen in areas of active mountain building. Because of the relationship of age and position, detailed field mapping of sedimentary beds is extremely important in all areas of paleontology. Data on subsurface rocks permit fossil beds from one area to be correlated with those of another on a local and regional scale. Thus fossils from a new locality that are of uncertain age can be dated by comparing them to those from an area of known age.

Similar age sedimentary rocks often have the same kinds of plant fossils. Some fossil plants from the 100 million year old mid-Cretaceous sediments of Kansas can be correlated with those of similar age from New Jersey and Czechoslovakia. Also, some 45 million year old Eocene age sediments from western Kentucky and Tennessee have fossil leaves and fruits that are nearly identical to those known from similar age sediments in Germany and England. Forest and swamp plants in England 60 million years ago were similar to those in North Dakota, western Canada, and Alaska at that time. Modern *Metasequoia* is presently restricted to a native range of central China, and modern *Ginkgo* has a similar restricted range in China. But fossils of both are quite common in sediments deposited 60 million years ago in western North America, Europe, and Asia. Today these trees are widely planted along streets and in yards in North America. Humans have returned them to parts of their former natural range.

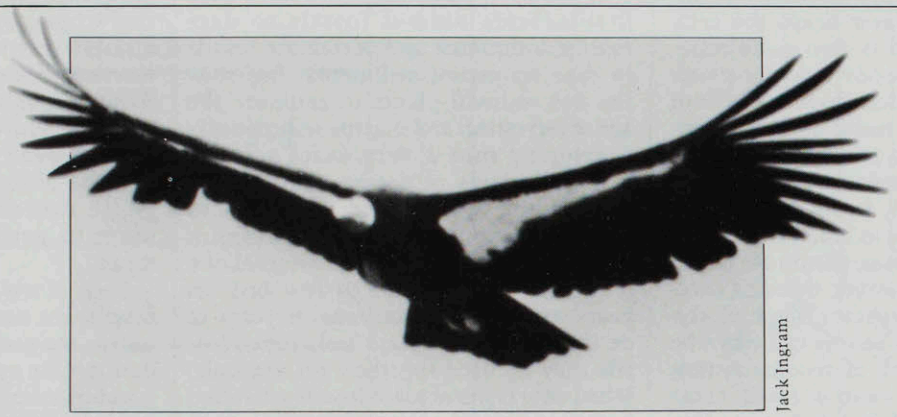
Even if we know the relative age of fossils, we cannot know their exact age unless we use some method of absolute dating. One method can be applied when a sedimentary sequence has been interrupted because of a special event such as the eruption of a volcano. Often, ash from a volcanic eruption can be found in sedimentary rock forming an ash bed up to a few inches thick and covering several hundred square miles. All the chemical elements in this ash bed were newly formed when the ash was deposited. Knowledge of the decomposition rates of certain unstable isotopes in the ash (the time it takes for rubidium to become strontium or potassium-40 to become argon, for example) makes absolute dating of the ash beds possible. (Radioactive isotopes of carbon can only be used for dating quite recent fossils — those from the last 40,000 to 50,000 years.)

Plant fossils are useful in biostratigraphy and important, even critical, in the study of the evolution of the life we have on the earth today. I find the study of fossil plants exciting and rewarding because it is possible to put in order several new pieces of the giant puzzle of the evolution and diversity of life.

David Dilcher is Professor of Paleobotany at Indiana University in Bloomington. He teaches courses in Paleobotany, the study of fossil plants, and Evolution and manages a research laboratory in which the study of fossil plants is actively pursued. His special area of interest is the fossil record of flowering plants and the study of the reproductive biology of the very early fossil flowers of the world. He has written many professional articles and edited special symposium volumes on these topics. He enjoys collecting fossil plants and has traveled to many parts of the world looking for fossils.

THE CALIFORNIA CONDOR

LIFE ON A SLENDER THREAD



Jack Ingram

by LLOYD KIFF

The early California naturalist, J.G. Cooper wrote of the California Condor in 1890, "...from my first observation of it in California, in 1855, I have seen fewer every year when I have been in localities most suitable for them. There can be little doubt that unless protected, our great vulture is doomed to rapid extinction." The same theme has been echoed in nearly every popular article on the condor during the intervening 93 years. Despite the fact that the condor is now the rarest bird in North America — less than 20 are thought to yet exist in the wild — the species has demonstrated a near miraculous capacity for survival, considering all the odds against it.

It is well known that condors were once more numerous and widespread in North America, although, like most unusually large animals, they were probably never abundant. Discoveries of fossils indicate that the huge vultures once ranged east to Florida, south to northern Mexico, and in the Pacific region from southern British Columbia south to Baja California. Visitors to the Page Museum of La Brea Discoveries can view the late Pleistocene remains of some of the numerous condors that perished in the asphalt pools, presumably while feeding upon earlier victims. The image of seething masses of condors swarming over the carcasses of long extinct mastodons, dire wolves, and saber-toothed cats has promoted the popular notion that the condor is a "Pleistocene relic," already on its way out when man came on the scene. However, unlike the mastodons, giant sloths, and teratorns (huge raptorial birds) so characteristic of La Brea, the condor apparently survived the Pleistocene in relatively good shape. For example, the species nested as far east as the Big Bend region of Texas as recently as 2,000 years ago, and numerous other Recent condor remains are still turning up in the caves of Arizona, New Mexico, and Nevada.

By the time Spanish explorers first encountered the condor in the early seventeenth century, the species apparently was already restricted to a 100-mile wide strip along the Pacific Coast. The causes for the contemporary prehistoric decline of the condor are not fully understood but are most likely linked to widespread climatic changes and possibly to the impact that Indian tribes, many of whom used the condor in various rituals, may have had on some local populations. Virtually all of the prehistoric condor remains known from the last few thousand years have been associated with human artifacts. It is not surprising that the giant birds, which weigh over 20 pounds and have a wingspread exceeding 9 feet, had a special attraction for Amerinds. Even now, the spectacle of an effortlessly soaring condor can command the attention of people who are ordinarily indifferent to their environment.

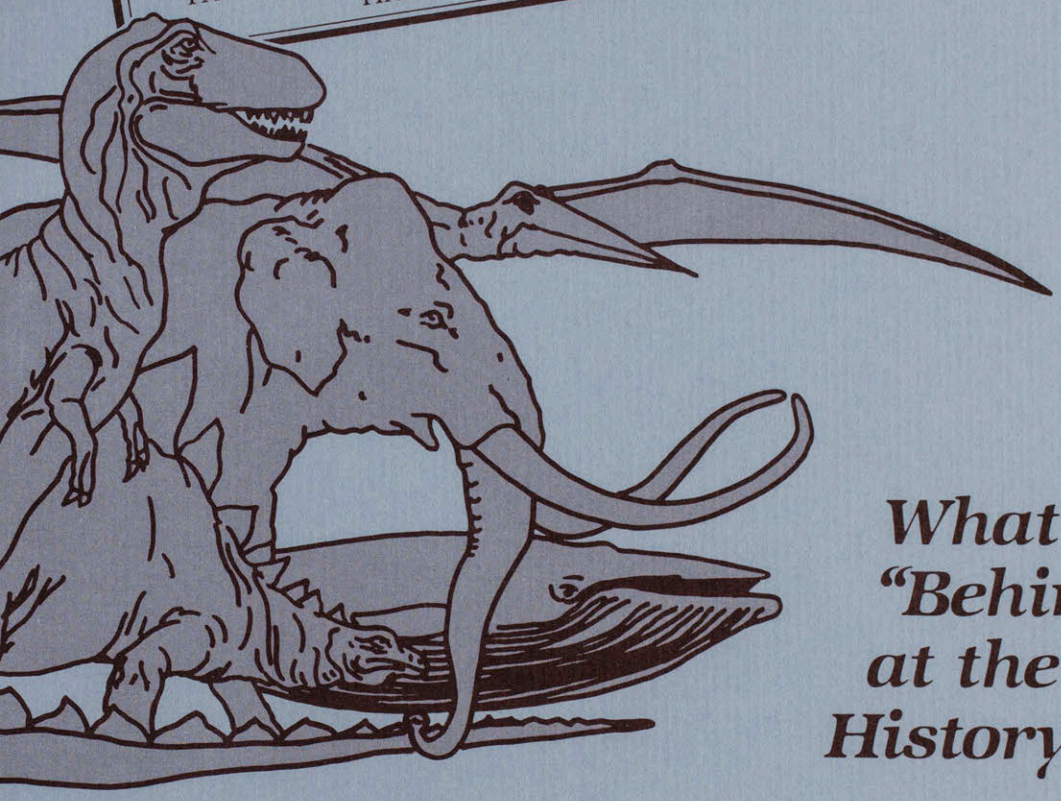
The causes of the more recent and catastrophic decline of the condor are better documented, and they are all related to man's activities. Within historical times, deaths of condors from natural causes are virtually unknown. The settling of the West and the advent of the vast Spanish *ranchos* with their great herds of cattle and flocks of sheep may have brought a bountiful new food supply into the range of the California Condor. However the almost inevitable tendency of the early settlers to shoot condors resulted in drastic losses of the birds during the nineteenth century. Although scientific and hobbyist collecting contributed to the loss of many more condors than was necessary for adequate study, shooting the birds out of mere curiosity was probably the single most important cause of the decline of the species in the nineteenth century. The capture of condors for sport, public display, or as private pets contributed to the loss of at least 40 condors from the wild, and over 70 eggs were collected between 1859 and 1943. Many early writers alluded to widespread poisoning of condors with strychnine-laced carcasses, but there are virtually no firsthand accounts of such incidents. The effect of range poisons, especially those presently being used for rodent and predator control, upon the condor population is still

TWO MONTHS AT TWO GREAT MUSEUMS

NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY, EXPOSITION PARK
PAGE MUSEUM OF LA BREA DISCOVERIES,
HANCOCK PARK

January/ February 1984

CALENDAR OF EVENTS



What wonders lurk "Behind the Scenes" at the Natural History Museum?

Come and find out at our "Members Only" Open House Night

Our annual Open House for Museum members will be held Friday, February 24, from 6:30 to 10:00 p.m. You are invited to explore the laboratories, workrooms, and collection storage areas as well as visit with members of the professional staff. Docent tour guides will be present to share their knowledge of the many treasures in the museum.

Reservations are required for this exciting museum adventure and reception. Please use the form at the left or call the Membership Office at (213) 744-3426.

ANNUAL MUSEUM OPEN HOUSE

I want to attend the Member's Only Open House at the Natural History Museum

_____

Name

_____

Address

_____

City Zip

_____

Day Phone

There will be _____ in our party.

(Please send the completed form to: Museum Membership Office, 900 Exposition Blvd., Los Angeles, CA 90007.)

SATURDAY FREE FILMS AT THE NATURAL HISTORY MUSEUM

The Family Film Series at the Natural History Museum provides a change of pace for visitors to the Museum and Exposition Park. Each Saturday afternoon, films of interest to adults as well as school age children are shown in the Jean Delacour Auditorium at 2 p.m.

The program for January and February includes the first five segments of the Emmy award winning BBC series "Elizabeth R." The series stars Glenda Jackson as Elizabeth I, one of the most powerful and controversial rulers of the Renaissance.

January 7	ELIZABETH R: THE LION'S CUB
January 14	THE ASCENT OF MAN: GRAIN IN THE STONE and CONNECTIONS: THUNDER IN THE SKIES
January 21	ELIZABETH R: THE MARRIAGE GAME
January 28	ELIZABETH R: SHADOW IN THE SUN
February 4	ELIZABETH R: HORRIBLE CONSPIRACIES
February 11	KIFARU—THE BLACK RHINOCEROS AND CARNIVOROUS PLANTS
February 18	(No film showing)
February 25	ELIZABETH R: THE ENTERPRISE OF ENGLAND

Admission is free and open to the general public (children under 15 years of age must be accompanied by an adult). Doors open at 1:30 p.m.; the program begins at 2:00. The films on January 14 and February 11 will also be shown at other locations in Los Angeles County this winter. For further information, call the Education Division, (213) 744-3342.

FREE FILMS AT PAGE MUSEUM

"The Ascent of Man: Grain in the Stone," and "Connections: Thunder in the Skies" will be featured at the Page Museum on Tuesday, January 10th. On Tuesday, February 14th, "Kifaru—the Black Rhinoceros," and "Carnivorous Plants" will be shown. The films will be screened in the Museum's Education Classroom; the museum is open free of charge on the second Tuesday of each month, and free admission to the films is included.

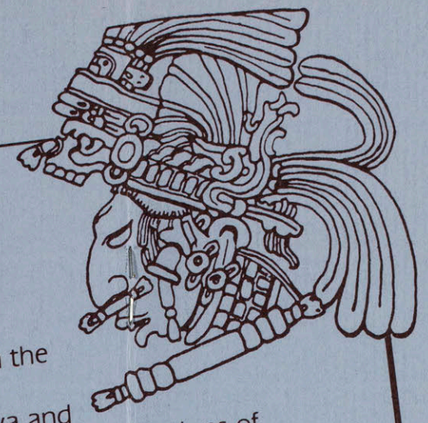
The film program begins at 1:30 p.m. and lasts about an hour and forty-five minutes. For further information, call the Page Museum, (213) 857-6324.

FREE SUNDAY CHAMBER MUSIC CONCERTS AT THE NATURAL HISTORY MUSEUM

The 36th season of Sunday Chamber Music Concerts at the Natural History Museum continues with diverse programs selected and coordinated by Philip Kahgan, Program Director. From 2 to 3 p.m. each Sunday, fine classical music will be performed by outstanding Southern California musicians in the Museum's Jean Delacour Auditorium; the programs are also broadcast live in stereo on radio station KFAC, 92.3 FM. The programs are produced by Richard Lipscomb.

January 1	SINFONIETTA STRINGS of the LOS ANGELES SOLO REPERTORY ORCHESTRA, music of Mozart, Purcell, Mendelssohn, Handel, Belden Leonard, and Mario Bruno
January 8	LOS ANGELES CHAMBER ENSEMBLE, music of Copland and Stravinsky
January 15	THE VERDUGO ENSEMBLE, music of Bach, Dowland, Sibelius, Grieg, and Godowsky
January 22	COMPOSITIONS BY KATHY HENKEL, Spectrum V Quintet and Guest Artists
January 29	THE WAKITA KOTO ENSEMBLE, Classical and contemporary music of Japan
February 5	THE WESTWOOD BAROQUE ENSEMBLE, music of Haim Shtrum, Bach, Pachelbel and Vivaldi
February 12	MURRAY KORDA and his MONSEIGNEUR STRINGS, Continental and Gypsy music of Europe
February 19	KAPLAN—MAYORGA PIANO DUO, music of Schubert, Infante, Hoagy Carmichael, Vincent Youmans, and Zez Confrey
February 26	THE CHARLES GOULD TRIO, music of Karl Reinecke, Charles Gould, and Francois Devienne

The concerts are open to the general public, and admission is free (children under 15 years of age must be accompanied by an adult). Additional program information is available through the Education Division, (213) 744-3342.



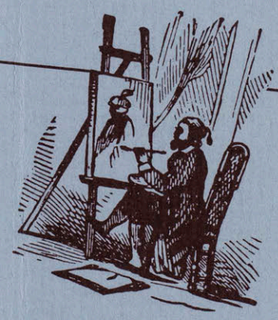
Yucatan Study Tour

April 6 to 22, 1984
$1610.00 (air fare not included)

This intriguing travel-study program on the Yucatan Peninsula of Mexico is led by Dr. Frederick J. Bove, specialist on Maya and Olmec civilizations. The 17-day tour includes explorations of Uxmal, Chichen- Itza, Palenque, and other famous Mayan cities. It also provides the opportunity to investigate many fascinating ruins well off the "beaten track." Highlights are visits to the the brick city of masks of Kohunlich, the false towers of Xpuhil, exquisitely sculpted Comalcalco, and the sacred cave of Balancanche.

If you would like more information on this program, please call the Membership Office at 213/749-3583.

Scientific Illustration Class



Frances Runyan, Instructor
Tuesday evenings, 6 p.m. to 9 p.m.
February 7 through May 1, 1984

A thirteen-week course in scientific illustration is being offered by the Natural History Museum this spring. Pen and ink and color wash are two of the techniques covered in this class, which is suited for beginning, intermediate, or advanced students.

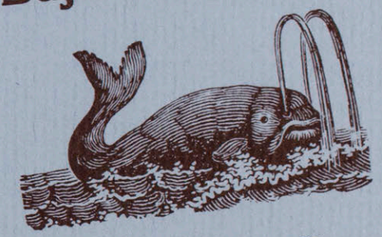
Frances Runyan has taught illustration at the University of Southern California and Otis Parsons Art Institute. Her line drawings of mushrooms and narcotic plants are currently on display at the museum.

The class fee is $85 for Museum Members and $95 for nonmembers. To enroll in the class or obtain further information, please call the Education Division at 213/744-3341.

Annual Museum Fundraising Ball

March is the month for the Annual Museum Fundraising Ball. Last year's Dinosaur Ball was a great success and one of the more exciting social events of the season. On **Friday night, March 16th,** the museum halls will once again be filled with music and romance. If you would like to dance and dine among the dinosaurs, call the Membership Office at (213) 744-3426 for further information on this year's gala affair.

Whale Watching in Baja California



February 11 to 18, 1984
$900 (from San Diego)

This exciting boat trip, led by Dr. Larry Barnes, Curator of Paleontology, and Dr. Gary Wallace, Curator of Botany, will be an exploration of the offshore islands of Baja California and the San Ignacio Lagoon where gray whales are easily sighted. The trip's highlight will be the opportunity to observe gray whale behavior at close range, including mating, breaching, and cow and calf interaction. During stops at San Benitos Island and Cedros and San Martin Islands, you will see many varieties of sea and shore birds, as well as elephant seals, harbor seals, sea lions and their pups.

You will travel aboard the QUALIFIER 105, one of the largest and best equipped sport-fishing boats of its kind in the world. Accommodations on the QUALIFIER include 15 air conditioned staterooms, hot and cold water, and a 43-passenger lounge with bar facilities. You will dine on fine food prepared in the ship's galley.

Because of the popularity of this trip, we urge early reservations for the limited spaces. If you would like to be a part of our annual whale-watching adventure, please call the Membership Office for more information at (213) 744-3426.

OPENING EXHIBITS

Celebrations of the Insect Form: Watercolors by Ray Bingham. January 17, 1984, through March 18, 1984.

CONTINUING EXHIBITS

A Miniature Christmas. Through January 8, 1984.

Finished in Beauty: Southwest Indian Silver from the Doneghy Collection. Through February 26, 1984.

A Collector's Legacy: Native American Artifacts. Through January 29, 1984.

Underwater Photographic Society 21st International Photographic Competition. Through February 12, 1984.

Laetoli: Footprints in the Ashes of Time. Through March 4, 1984.

Mushrooms Up and Down Los Angeles. Through August 1984.

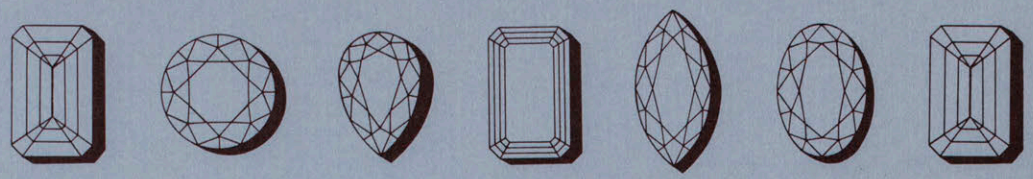
The Gregorian Calendar. Through September 1984.

California Condors. Through October 1984.

The Natural History Museum, located at 900 Exposition Boulevard, Exposition Park, Los Angeles, California 90007, is open from 10 a.m. until 5 p.m., Tuesday through Sunday. The museum is closed Mondays, Thanksgiving, Christmas, and New Year's Day. Admission is free to Museum Members. For further information, please call 213/744-3414.

The Page Museum of La Brea Discoveries, located at 5801 Wilshire Boulevard, Hancock Park, Los Angeles, California 90036, is open from 10 a.m. until 5 p.m., Tuesday through Sunday. The museum is closed Mondays, Thanksgiving, Christmas, and New Year's Day. Admission is free to Museum Members. For further information, please call 213/857-6311.

Please consider giving a Museum Membership to a friend. By doing so, you will contribute to the development of two important cultural institutions. For further information, please call the Membership Office, 213/744-3426.



WEEKEND GEM SEMINAR

AN INTRODUCTION TO DIAMONDS AND COLORED STONES

The Gemological Institute of America, in cooperation with the Natural History Museum, is offering a comprehensive introductory course in gemology. The course is designed to be of value to the professional jeweler, amateur mineralogist, and gem collector alike. No previous knowledge of gemstones is required.

The weekend Gem Seminar will be conducted by two GIA instructors, one an expert in diamonds, the other a specialist in colored stones. The course consists of lectures geared to the gem enthusiast plus films and vivid slide presentations. The resources of the Natural History Museum, including the collections of the Gem and Mineral Hall, will complement the subjects presented. A certificate will be awarded to all participants upon completion of the seminar.

The course contents are as follows:

- the origin, source, and mining of gems
- gemstone distribution and cutting
- factors considered in grading a diamond: color, clarity, and cut
- the wide variety of colored stones
- factors that effect the value of colored gems
- fancy shape and fancy color diamonds
- gem simulants and treatments
- gemstone jewelry, fashion, and lore
- optical properties as they relate to a gem's beauty
- gem identification techniques
- answers to your specific questions about gemstones

The weekend seminar begins with a wine and cheese social hour, Friday, March 2, at 7 p.m. All-day sessions on Saturday and Sunday, March 3 and 4, begin at 9 a.m. and end at approximately 5 p.m. The cost of the course is $155, and includes a box lunch each day. Reserved parking will be available for Saturday and Sunday in the museum lot. To register, please complete the form below. For additional information, please phone the Membership Office at 213/744-3426.

WEEKEND GEM SEMINAR

$155 per person

Yes, I would like to attend the Weekend Gem Seminar

Name _____

Address _____

City _____ State _____ Zip _____

There will be _____ in my party.

☐ Check enclosed (please make payable to "Natural History Museum Foundation")

☐ Charge to my VISA or MasterCard (please indicate which card)

Card Number _____ Expiration Date _____

Signature _____

(Please send this form and your check or credit card information to the Membership Office, 900 Exposition Blvd., Los Angeles, CA 90007.)

The nest and egg of the California Condor (Gymnogyps californianus).

Don Bleitz

A young condor about 3 to 5 days old.

Don Bleitz

Don Bleitz

A young bird about 50 days old.

Don Bleitz

A condor about 4½ months old.

controversial and poorly investigated.

Through a combination of man-related mortality factors, none of which had figured in the evolution of the species, the condor's range was reduced by 1920 to a wishbone-shaped area in the mountainous portions of central California and a tiny remnant population (which was soon to vanish) in northern Baja California. Except for the apparent abandoning of the outlying portions of this range, particularly portions of the Coast Ranges in Monterey and San Luis Obispo Counties, the boundaries of the condor's range have not changed much in the intervening years. The profound changes, especially expanding agricultural and housing developments, which have occurred *within* the condor's range in the intervening period, however, have increasingly influenced the birds' movements in search of food. Presently, the most important foraging areas are on the huge ranches located in the corridor of grassy foothills surrounding the southern end of the San Joaquin Valley, and preservation of a significant portion of these lands is essential to the condor's ultimate survival.

Despite the fact that the heart of condor country has traditionally been located within an easy drive of downtown Los Angeles, little formal scientific attention was paid to the species until 1939. In the early spring of that year, a young University of California graduate student, Carl Koford, initiated a comprehensive life history study of the condor, a project which was to last for over a decade (with a hiatus of a few years during World War II). Koford hiked and camped for months at a time in the rugged chaparral-covered mountains of Ventura and Santa Barbara Counties and compiled for the first time the basic details of the life history of the condor. He was frequently accompanied in the field by Ed Harrison, an amateur naturalist from Encinitas, who obtained film footage of wild condors that is still unique. Koford's study, which was eventually published by the National Audubon Society in 1953, and Harrison's film were helpful in achieving the establishment in 1947 of the Sespe Condor Refuge in the Los Padres National Forest near the small town of Fillmore. The refuge, which encompasses rough canyons and cliffs containing some of the most important condor nesting sites, was enlarged in 1951 to its present 53,000 acres.

As so often happens after the appearance of a comprehensive monograph, there was little immediate follow-up to Koford's recommendations for preserving the condor. Aside from occasional visits to the Sespe refuge by part time condor patrolmen who were paid jointly by the U.S. Forest Service and the Na-

An adult condor perched in the top of a dead Big Cone Spruce.

Don Bleitz

California Condors, an exhibit currently on display at the Natural History Museum, consists of several adult and juvenile condors collected prior to 1935. Between 1981 to 1983, Taxidermist Paul Hill cleaned, refurbished and remounted them for display. His painstaking work has resulted in three cases of beautifully preserved birds. The exhibit opened on June 10, 1983 and will continue through October 1984.

tional Audubon Society, little formal attention was paid to the species during the 1950s. Since most condor activity then, as now, occurred outside the boundaries of the refuge, trends in the whole condor population could not be adequately monitored. A year-long study by Eben and Ian McMillan, San Luis Obispo County rancher-naturalists, and Dr. Alden Miller, of the University of California, which was commissioned by the National Audubon Society in the early 1960s, confirmed what many conservationists had feared — the condor population was estimated to have declined by as much as one-third since Koford conducted his landmark study in the 1940s.

Shortly after the publication of the Miller-McMillan report, the U.S. Fish and Wildlife Service hired its first condor biologist, Fred Sibley. He proved to be a field man just as rugged as Koford, and his rope climbing and hiking exploits have become part of the condor legend. Sibley's first and most pressing duty was to consider the impact that a proposal to dam Sespe Creek in the vicinity of the condor refuge might have on the condor. Local voters eventually turned down the proposal, which, according to Sibley's predictions, could possibly have meant the extinction of the condor. During his tenure Sibley routinely climbed into all known active condor nest cavities to monitor breeding success, and he gathered any eggshells, bone fragments, and other organic material he found on the bare floor of the caves. Later analyses of the eggshell fragments revealed that they averaged over 30 percent thinner than normal, apparently the result of contamination of the laying females by the common pesticide, DDT. The true severity of the effects of DDT on the condor population between 1947, when the pesticide was introduced in California, and 1972, when its domestic use was banned, may never be known. But it is highly probable that the eggshell thinning it caused led to numerous broken eggs and thus fewer condors over the years.

The condor decline detected by the McMillans and further documented by Fred Sibley and his successor, Sanford Wilbur, continued relentlessly through the 1970s. As the number of condors became ever smaller, the amount of public attention focused on the plight of the species increased. Various committees were established by governmental agencies and conservation organizations to examine the condor situation critically. The evidence for the impending extinction of the species was overwhelming by 1979, when a committee of experts brought together by the American Ornithologists' Union concluded that emergency measures should be implemented as soon as possible to save the species. The essential elements of the condor program recommended by the AOU Condor Committee and the Federal and state government interagency Condor Recovery Team included a vigorous program of breeding condors in captivity, accompanied by an equally vigorous program to protect the condors remaining in the wild population. In order to identify critical condor habitat, it was recommended that several wild condors be trapped and equipped with radio transmitters so that their movements could be followed in detail. To implement this dramatic plan of action, a new Condor Research Center was established in Ventura by the U.S. Fish and Wildlife Service and the National Audubon Society in 1980.

It is said that the road to hell is paved with good intentions; the converse has too frequently been true for the biologists at the Condor Research Center. Surprisingly bitter opposition to the proposed condor management program was quickly mounted by the Friends of the Earth, some elements of the Sierra Club, and other protectionist groups that have traditionally been suspicious of governmental manipulations of wildlife. Indeed, for the past few years, the condor has served as a focal point of disagreement between those groups, who evidently oppose "hands on" management of animal populations on philosophical grounds, and those, including the National Audubon Society, National Wildlife Federation, and the majority of professional biologists, who regard techniques such as captive breeding, radiotelemetry, and supplemental feeding as essential tools for saving an abused species.

The accidental death of a condor chick being handled by Condor Research Center personnel in the summer of 1981 did much to fuel the fears of the opponents of the condor program and resulted in the loss of at least a year of precious time before the State Fish and Game Commission, which has ultimate authority over condor matters, would permit the resumption of the program.

However, thanks to a gradual series of successes — and a concomittant lack of conspicuous failures — the condor program appears to be back on track. The past breeding season was one of spectacular success for would-be condor saviours and, presumably, for the condors as well. Young were successfully hatched at the San Diego Zoo from four eggs that had been removed from wild condor nests; this was the first time that this feat had been accomplished (or attempted) in captivity. Two condor nestlings were also taken for captive breeding purposes, and they joined three other condors of various ages at the Los Angeles Zoo. The net result of the manipulations was that 1983 was the first year in recorded history when the total condor population increased rather than declined.

Man has traditionally saddled the California Condor with an unnaturally high rate of mortality, and there is little hope that all man-induced causes of condor deaths in the wild can be totally eliminated. It seems likely, therefore, that the only way to save the species is to promote an unnaturally high rate of productivity. Although condors typically breed successfully only every two years in the wild, they have the commendable tendency to replace an egg that is lost soon after it is laid, as was verified in three instances during the past breeding season. Taking advantage of this behavior, condor managers can theoretically increase the rate of condor productivity up to six times the normal rate. At the very least, it should be possible to establish a sizeable captive breeding flock of condors without creating a net loss in the wild population.

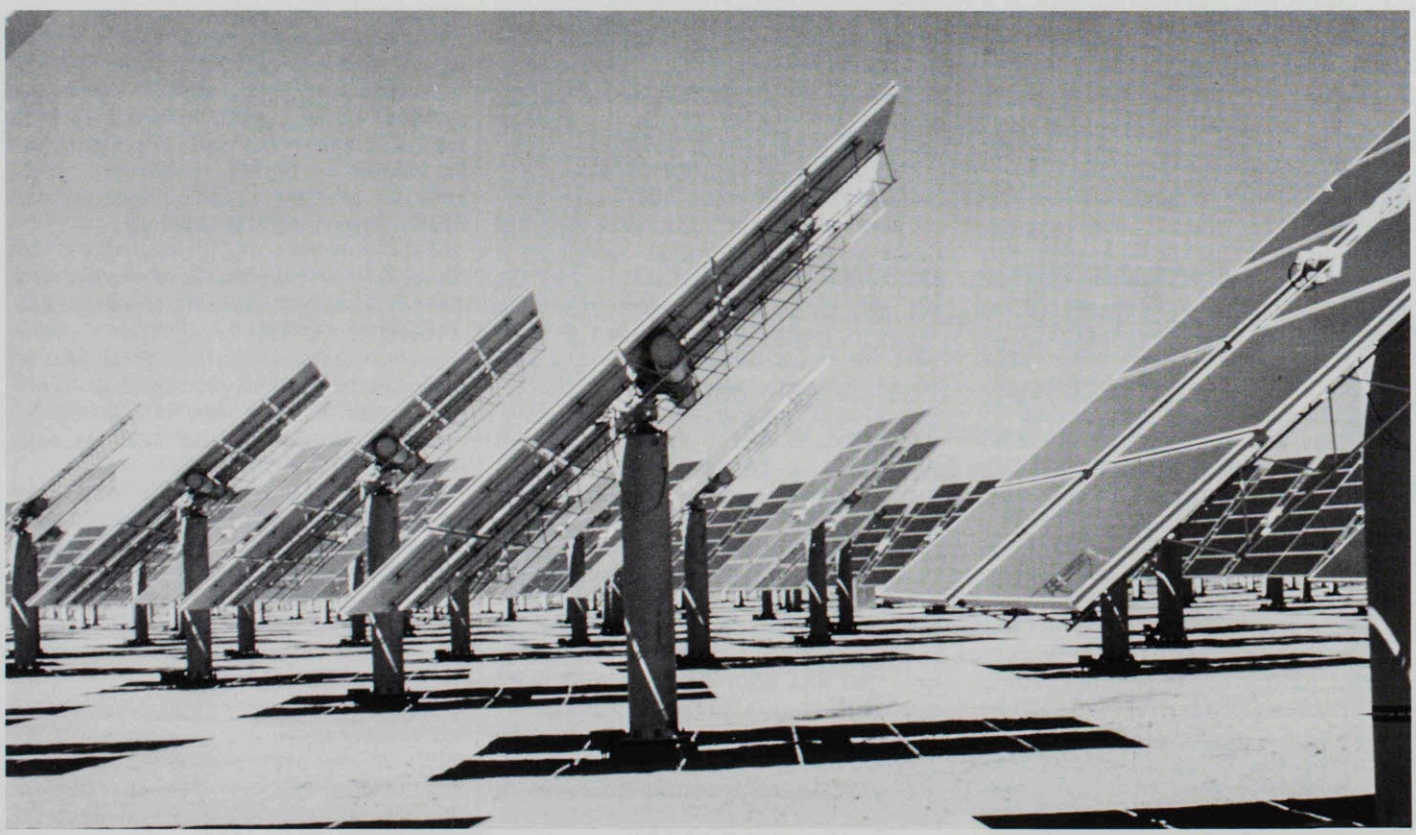
Few knowledgeable persons, including those philosophically opposed to the condor program, doubt that the California Condor can be bred successfully in captivity. The real test of the current management approach, however, will come when captive-produced birds are ready to be released to the wild. Will such birds be successfully integrated into the existing condor population, or will there even be any condors left in the wild by the time such releases can be attempted? The answers to such questions are a matter of enlightened speculation at this point, but the prognosis for the species presently appears to be improving. If the condor is saved, it will represent one of the most dramatic conservation victories in history, considering the fact that the species was nearly written off a century ago.

Lloyd Kiff, who is director of the Western Foundation of Vertebrate Zoology, has studied the effects of DDT on condor eggs and was senior author of a scientific paper describing this phenomenon. He is also proud to have been founder of the Annual Condor Watch and Tequila Bust, now in its 12th year.

Two photographers contributed to this article. The series showing condors at various stages in their development was taken in 1944 and 1945 by Don Bleitz, an engineer and manufacturer who has devoted much of his free time to studying and photographing condors. Jack Ingram, a free-lance photographer, is another person vitally interested in condor preservation; his photograph of an adult soaring over its range in southern Kern County appears on the first page of this article.

BIRDS AND ELECTRICAL ENERGY PRODUCTION: DO THEY MIX?

by ELIZABETH ANNE SCHREIBER
and RALPH W. SCHREIBER



Mirrors at the Solar One facility near Daggett, California. This computerized array tracks the sun to focus its rays onto the receiver. There, water is heated to 1,000 degrees F to produce steam, which moves the turbine to produce electricity.

The phenomenon of bird migration has long fascinated and awed man. In recent years we have learned that our manmade structures often pose a threat for birds in flight. They can usually avoid buildings and towers during daylight hours but have a difficulty doing so at night, when most migration occurs. In the United States alone millions of birds die annually from collisions with structures, and as many as 30,000 have died colliding with one TV tower in a single night. Many millions of birds migrate each spring and fall throughout the world, and scientists are beginning to investigate methods to help birds see obstacles in their path.

A new potential flight hazard for migrating birds is in the development of alternate energy sources, such as wind turbines, solar power and geothermal power, all of which will put more structures into the migratory flyways. The Southern California Edison Company (SCE), which supplies most of southern California with power, has asked the Natural History Museum's Section of Ornithology for assistance in determining what effect these structures will have on birds. We began these studies in the summer of 1981 in the southern California desert, and they continue at present.

SCE's present goal, in part, is to harness wind, solar, and geothermal energy for the production of electricity. Although using wind to produce electricity is not a new idea, the technologies for efficient, large-scale production are just now being developed. Wind-turbine generators, which exist in a variety of shapes and sizes, fall into one of two general categories: (1) towers similar to a windmill but much larger (horizontal axis turbine) or (2) structures resembling a huge egg beater (vertical axis darrieus). The environmental influences of such large generators are not yet known.

Commercially produced solar power involves constructing many acres of movable mirrors called heliostats, which focus the sun's rays onto a central tower. This concentrated sunlight boils water creating steam, which drives a turbine, thus producing electricity. The first large-scale solar-generating plant of this type was recently developed and constructed by the Department of Energy in conjunction with SCE in the Mohave Desert near Daggett, California. Environmental concerns with solar facilities are that birds flying through the intense beams of sunlight may be burned or blinded, or they will become confused and collide with the mirrors on other facility structures.

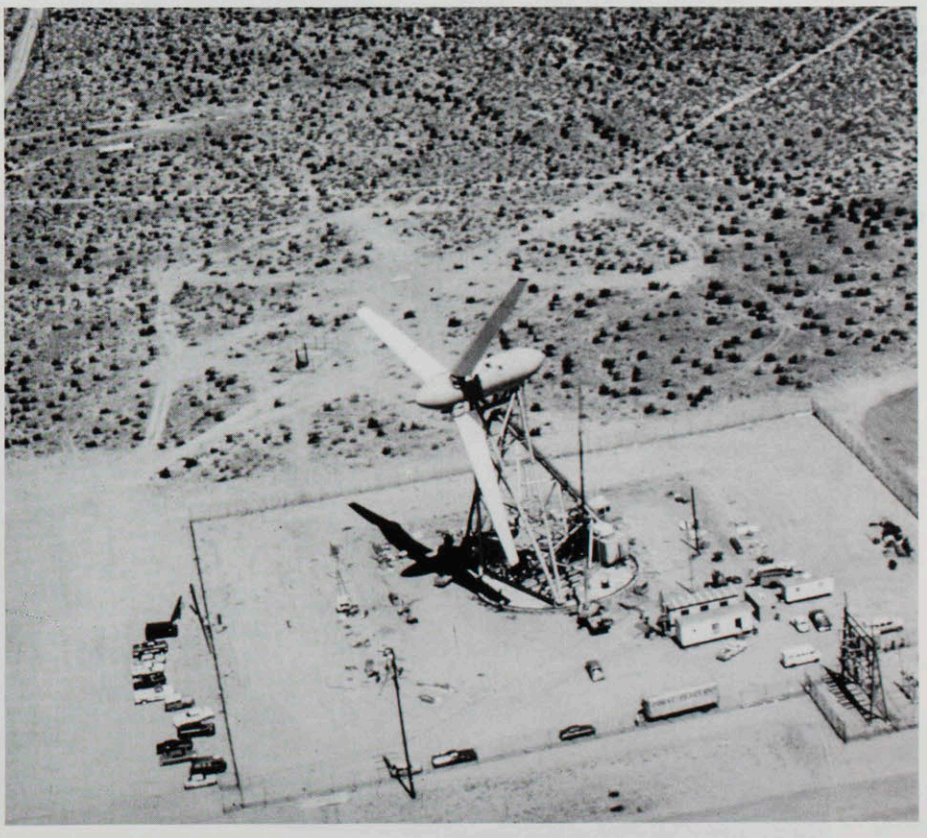
For both solar- and wind-energy sources, the deserts of southern California are ideal due to the high average wind speeds and almost incessant sunshine. Although these technologies do not require the use of nonrenewable fossil fuels, they do require much land for their operation, and if developed without care, might damage the desert ecosystem.

The production of electricity from geothermal energy takes advantage of heat sources trapped just below the earth's surface, similar to those in Yellowstone Park. Energy is produced fom these trapped heat pockets by drawing hot water from them, creating steam that is used to operate a turbine, producing electricity. Although not as visually dramatic as the geysers of Yellowstone, a major geothermal resource area is located at the southern end of the Salton Sea. This area is also very important for birds in California. Over 250 species have been observed at the Salton Sea, and over 150 appear there regularly.

The results of the Ornithology Section study are most interesting, detailing previously unknown facts about bird migration, particularly in southern California. It appears that more birds fly north

Left: The Solar One collecting tower in the California desert showing the bright light caused by the sun's rays focused from the surrounding 1,818 mirrors.

Below: The Bendix wind-powered turbine in the San Gorgonio Pass near Palm Springs, California. This machine is 190-feet high.



The radar and night-vision equipment setup devised by the Ornithology Section of the Museum to study nocturnal bird migration in the southern California deserts.

through the Coachella Valley during spring than in the fall when they utilize the coast more. This may be because the desert is drier in fall and contains less food. During the spring migration, most birds in the Coachella Valley fly at right angles (east) to their ultimate northern destination because of the high westerly winds in the valley. Under calm or low winds, bird movement is more northerly.

Although year-to-year variation occurs, estimates in 1982 indicate that as many as 50 million birds use the Coachella Valley as a spring migratory pathway. The peak period was from mid-April through May. During fall 1982, movement south occurred from mid-September through October, although birds were present in lower numbers than in spring.

The majority of migration in the desert occurs from sunset to midnight, tapering off thereafter and being lowest during the day. How does one study nocturnal movements of birds which can weigh fewer than 10 grams, have a wing span of fewer than ten inches, and fly as high as 3,000 feet? We had to develop methods to "see" birds at night.

Two basic devices are used: radar and nocturnal surveillance telescopes. Both of these were originally developed for military use. The Ornithology Section, in cooperation with Dr. Sidney Gauthreaux, Jr., of Clemson University, is using both of these devices in our migration study.

For determining altitude and density of nocturnal migrants, we modified a portable marine radar with a special antenna for observing a vertical portion of the sky. A bird appears as a point of light on the radar screen along a scale that indicates the bird's altitude. To actually see the birds, a night-vision scope connected to a TV camera is aligned with the radar in such a manner that the same portion of the night sky is observed by both instruments. All equipment is mounted in a small trailer and utility van and can easily be transported to different locations.

One of SCE's main concerns is the altitude of migration. Do birds actually fly low enough while migrating to run into a 300-foot high tower? Our studies indicate that most birds fly from 600 to 1,200 feet above ground, with only approximately 12 percent passing within 300 feet of the ground.

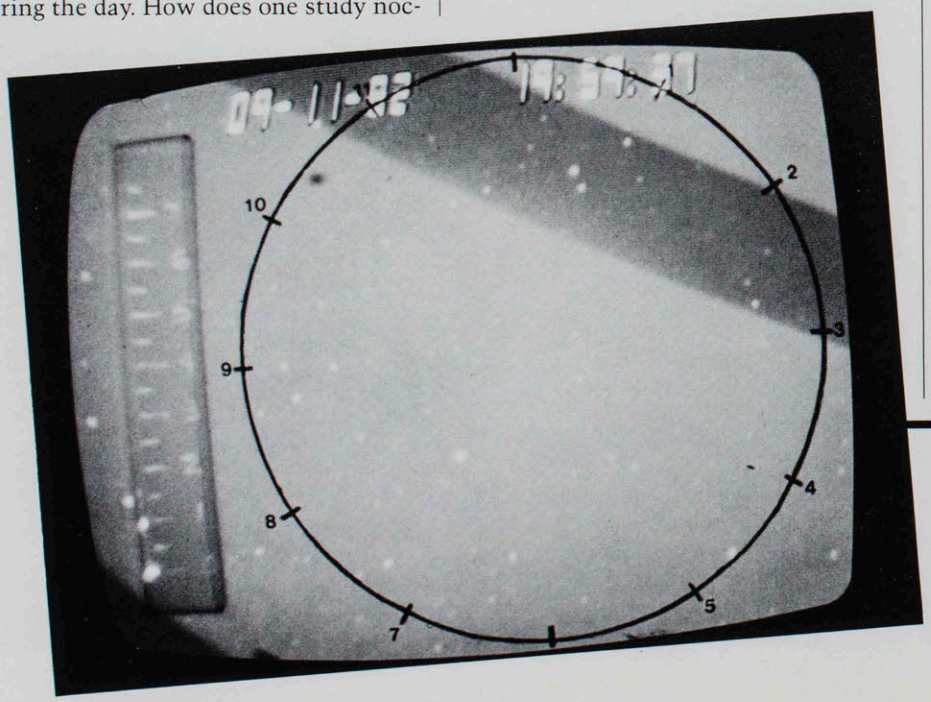
We also make daytime observations of bird density, species composition, and movement patterns, particularly around the Solar One Facility near Daggett, California. This 130-acre solar plant consists of 1,818 mirrors or heliostats and a central tower 300 feet high. Temperatures near this tower during the day can exceed 1,000 degrees F. The data gathered clearly indicate that operation of Solar One has little or no effect on wildlife. During one year of study, only 5 birds are known to have died from exposure to the concentrated heat produced by the heliostats and only 20 birds collided with plant structures.

As these studies continue, our understanding of the relationship between birds and man's search for new forms of energy will expand. The information will help Southern California Edison develop criteria for the deployment of their wind turbines, solar plants, and geothermal facilities, choosing areas where birds are least disturbed. No source of power is totally without effect upon our environment. As the demand for power increases, we must search for the least harmful ways to produce it. We believe our bird migration studies are contributing to those efforts, as well as providing important new data on bird migration in the western United States.

Elizabeth Anne Schreiber is a Research Associate of the Ornithology Section of the Natural History Museum; her husband, Dr. Ralph W. Schreiber, is Curator of Ornithology for the museum.

The field staff members for this project are Robert L. McKernan (Project Manager), Ross E. Landry, Michael D. McCrary, and William D. Wagner.

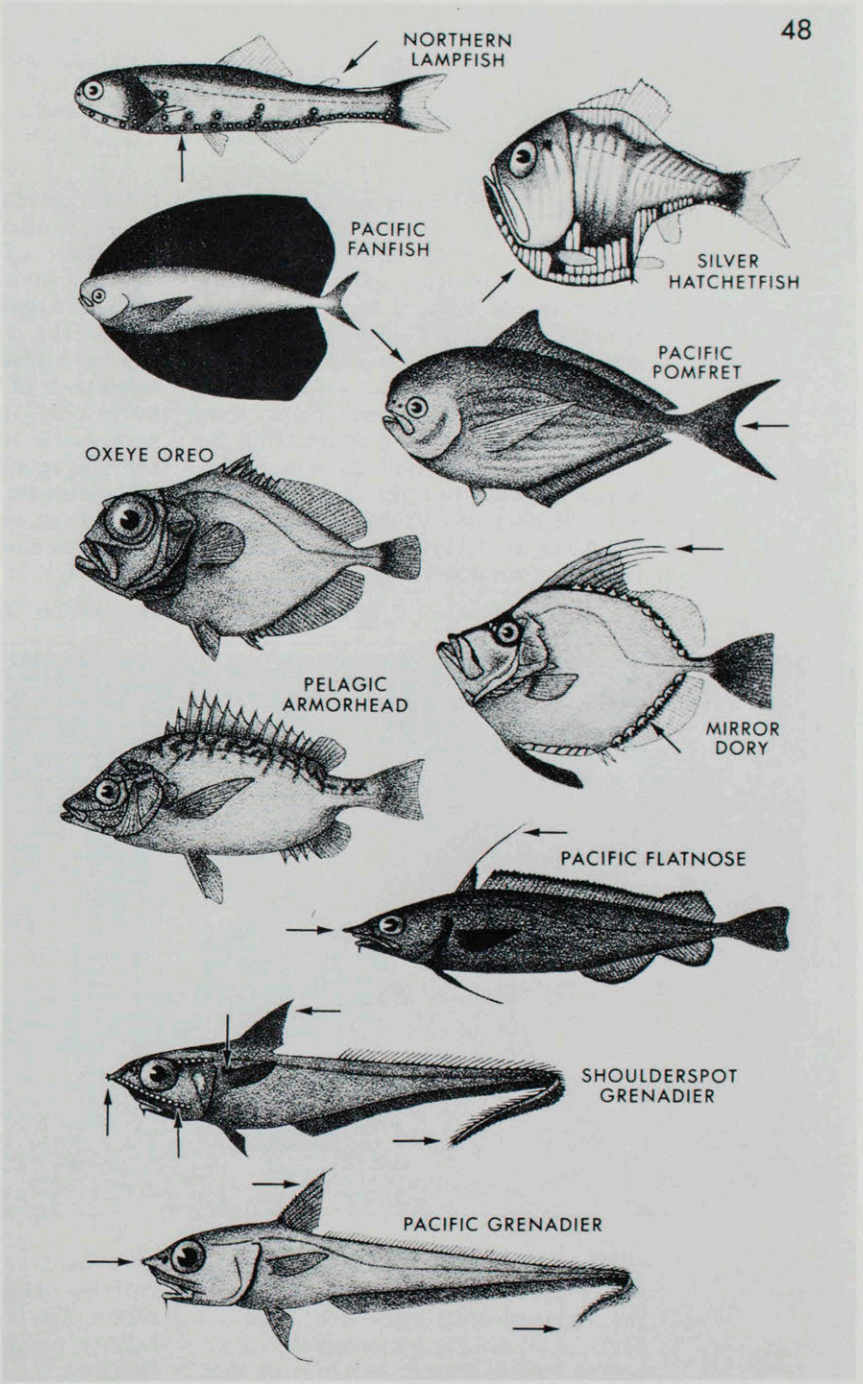
Photographs courtesy of Southern California Edison Co.



View of the TV screen from which we record sightings of birds moving through the radar beam (left side bar graph) that gives the altitude at which the bird is flying, and across the Night Vision Scope field (clock face) that gives the direction the bird is flying. This exposure was made at 7:59 p.m. on September 11, 1982. The largest points of light on the screen are birds.

NEW GUIDE TO PACIFIC COAST FISHES

Plate 48 from A Field Guide to Pacific Coast Fishes, *showing deepsea and oceanic fishes that are seldomly encountered by sportfishermen.*



A Field Guide to Pacific Coast Fishes of North America, *by William N. Eschmeyer and Earl S. Herald, illustrations by Howard Hammann. Houghton Mifflin Company, Boston, 1983; 348 pages, 1 map, 48 plates (22 in color) and 44 text figures. Hardcover, $19.95; soft cover, $11.95.*

The Peterson Field Guide series now includes the first guide to fishes of the Pacific Coast of North America from the Gulf of Alaska to Baja California. The heart of the new book is the collection of plates depicting many of our Pacific Coast fishes in color for the first time. The color plates are devoted to the larger and more colorful fishes likely to be seen underwater or caught by sportfishermen; the plates are arranged so that similarly colored fishes are grouped together to highlight differences, making it easier to identify them. Particularly striking are the color illustrations of 58 of the 60 or more species of rockfishes, which are important commercial and sport fishes; text figures highlighting many of the anatomical differences will allow fishermen to identify their catch on characters other than color. Many small, cryptic or seldomly encountered fishes and many deep-water species are illustrated in black and white drawings.

Illustrations comparing the heads of hammerhead sharks, the teeth of many species of sharks, the eggs or egg cases of hagfishes, sharks and rays, and many other details of fish anatomy are included as an additional aid to identification. (The figures of shark teeth do not show as much variation as we know the actual teeth do, and one must pay close attention to the scale of each drawing.)

The guide is devoted to marine fishes, but one true freshwater fish—the carp—is covered since it occasionally gets into upper San Francisco Bay. Several other species could have been included on this basis, such as mosquito fish and tilapia, which are common in the upper portion of some bays and coastal lagoons in southern California.

This guide is intended for use on fishing trips and other outings where fish may be encountered. Perhaps with this in mind, the hard cover is a smoothly coated green rather than the familiar blue cloth. The soft cover edition retains the blue and white tradition of the Peterson Guides. Even though the guide is designed for use outdoors, care should be taken not to get water on the plates, which will then stick together if not allowed to dry separately.

I have carried the guide on several trips already and find it very useful. It fills a long-vacant niche in the Peterson series, and it should quickly become very popular with everyone interested in Pacific Coast fishes.

Camm C. Swift
Associate Curator of Ichthyology,
Natural History Museum

CELEBRATIONS OF THE INSECT FORM

WATERCOLORS BY RAY BINGHAM

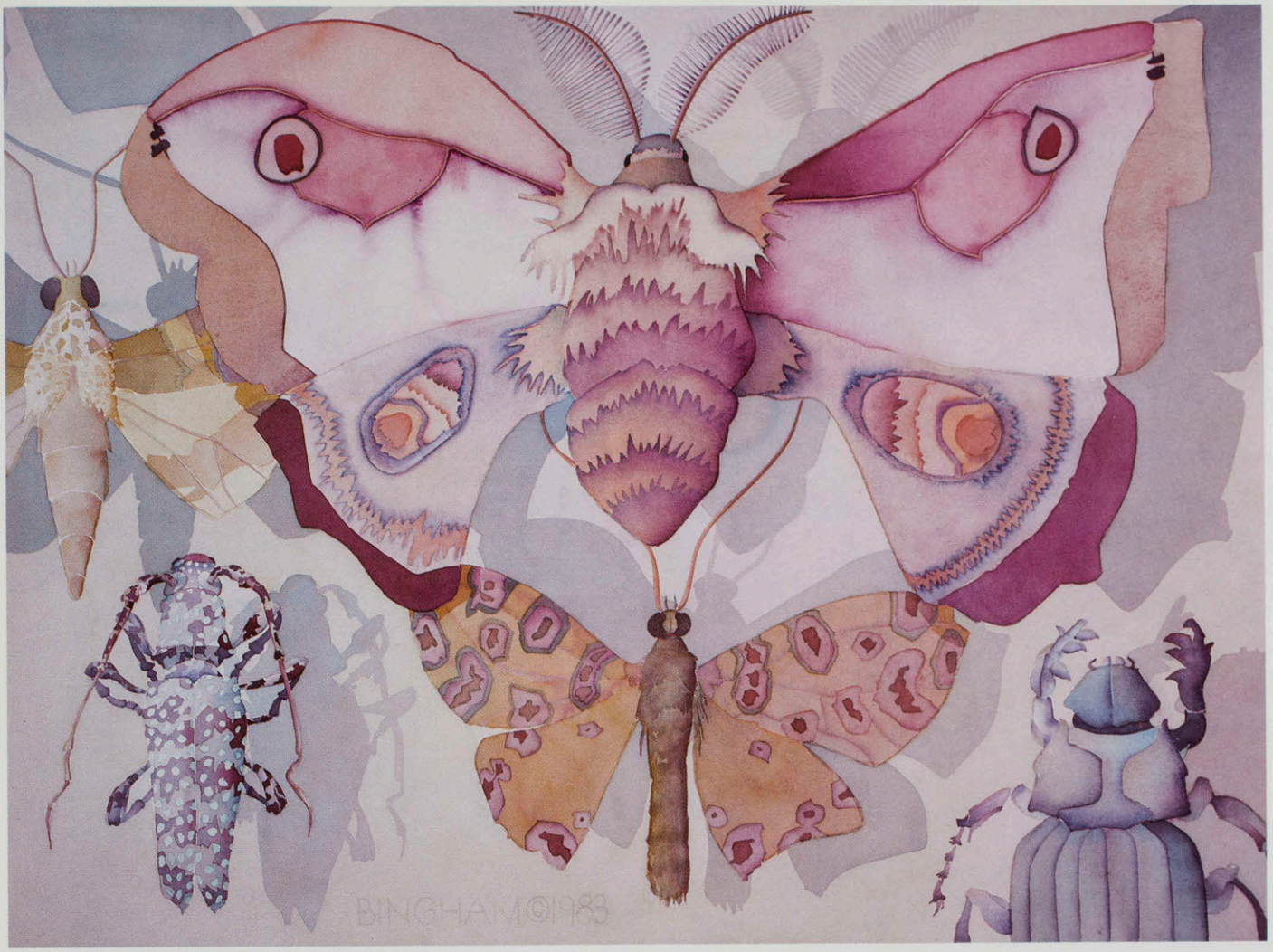
"Every one has heard the story which has gone the rounds of New England, of a strong and beautiful bug which came out of the dry leaf of an old table of apple-tree wood, which had stood in a farmer's kitchen for sixty years, first in Connecticut, and afterward in Massachusetts,—from an egg deposited in the living tree many years earlier still, as appeared by counting the annual layers beyond it; which was heard gnawing out for several weeks, hatched perchance by the heat of an urn. Who does not feel his faith in a resurrection and immortality strengthened by hearing of this? Who knows what beautiful and winged life, whose egg has been buried for ages under many concentric layers of woodenness in the dead dry life of society, deposited at first in the alburnum of the green and living tree, which has been gradually converted into the semblance of its well-seasoned tomb,—heard perchance gnawing out now for years by the astonished family of man, as they sat round the festive board,—may unexpectedly come forth from amidst society's most trivial and handselled furniture, to enjoy its perfect summer life at last!"

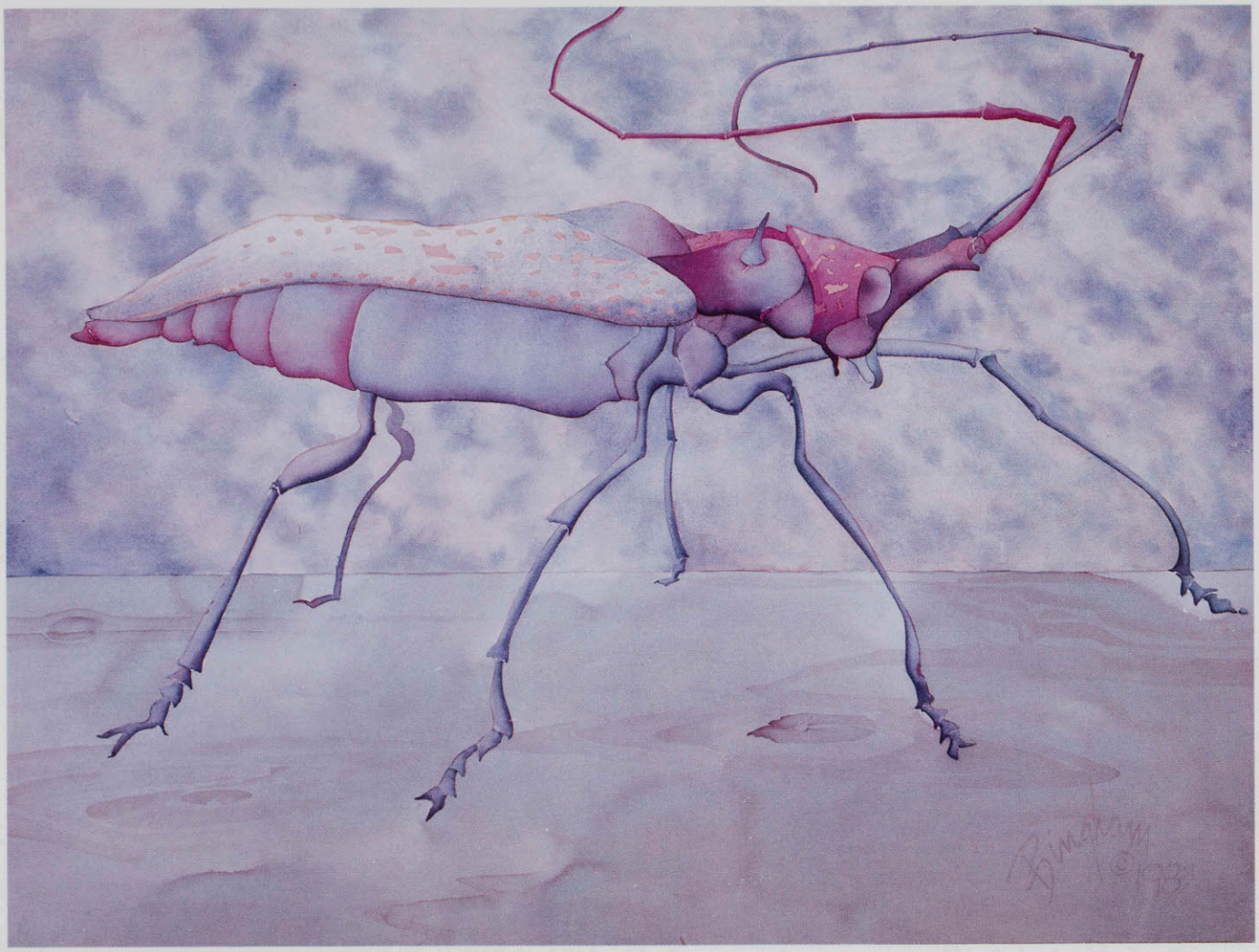
Henry David Thoreau, *Walden*, 1854

Like Thoreau's wood boring beetle, which resurfaces after spending nearly one hundred years embedded in an oak table, Ray Bingham's colorfully interpreted insects seem to be enjoying their "perfect summer life at last." Bingham, a local artist, has chosen many species of insects as the subjects for his watercolors and drawings. The pieces, on show at the Natural History Museum from January 17 to March 18, 1984, are strong studies in both entomology and watercolor technique. They celebrate the variety and beauty of the insect body form and function.

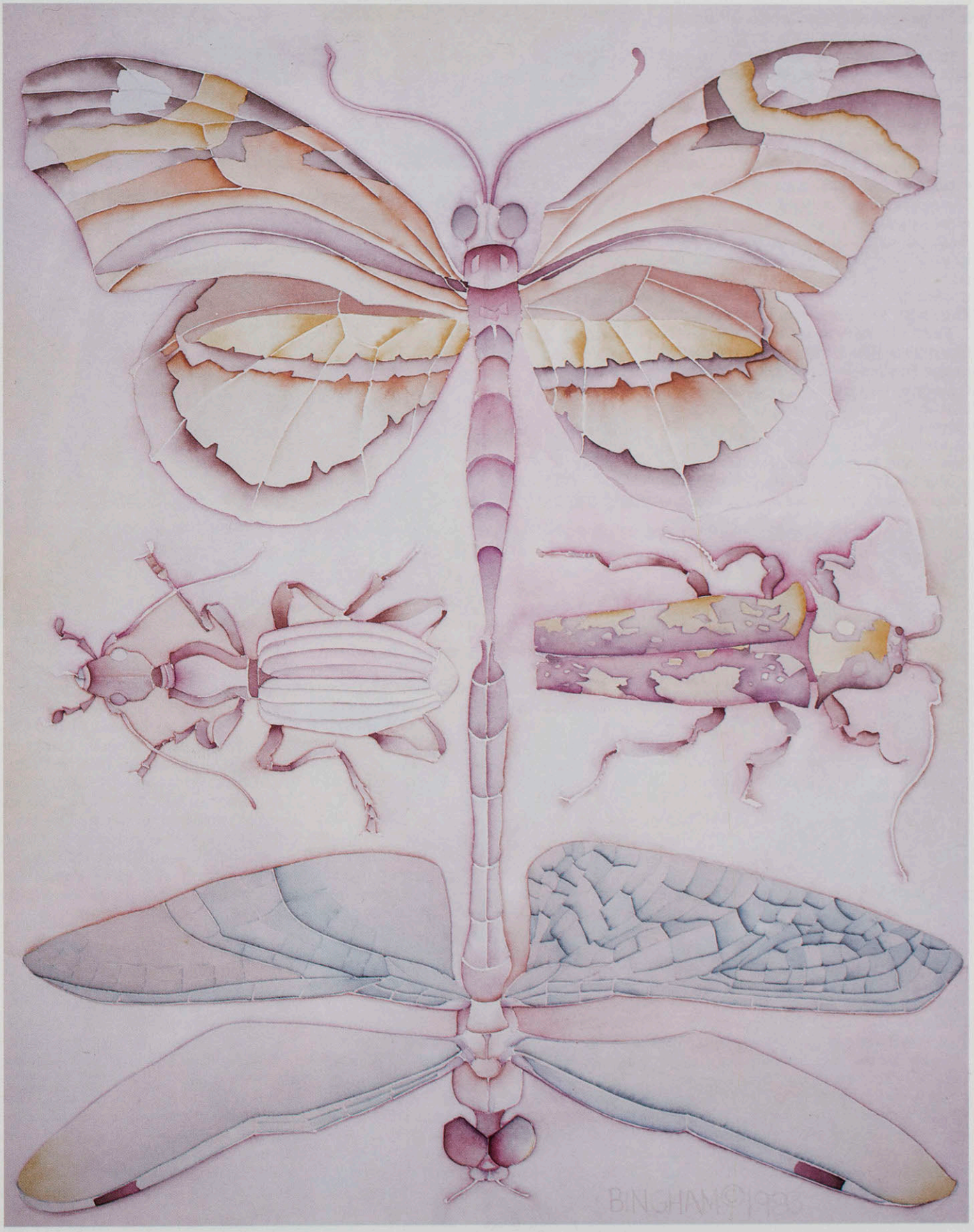
Ray Bingham received a master of fine arts degree from Claremont University. His art has been shown nationally and internationally since 1972. He lives and works in Long Beach.

Page 24: Mexican beetle with variations, *1983, 19 x 42¼ inches.*
Page 25: Mourning Cloak with ginger, *1983, 38¼ x 29 inches.*
Page 26: Cicada with beetles, *1982, 25 x 25 inches.*
Page 27, top: Moths with beetles, *1983, 28¾ x 38¾ inches.*
Page 27, bottom: Tropical beetle with variations, *1983, 19 x 42 inches.*





Page 28, Beetle on a box, *1983, 31 by 41¼ inches.*
Page 29: Dragonfly with green wings, *1983, 35½ x 28¼ inches.*

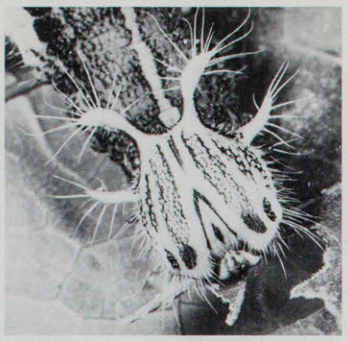


(Continued from page 2)

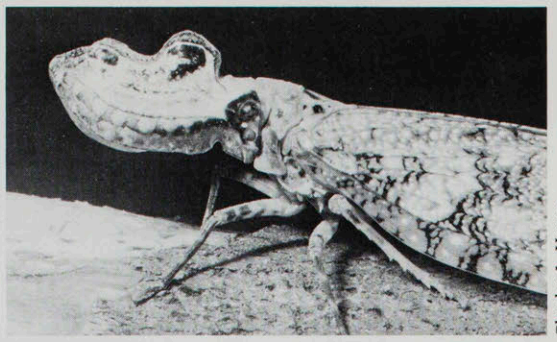
excess of 300,000 fossils. The consolidation of these two carefully documented collections into the Invertebrate Paleontology Section will add to the Museum's increasing usefulness as an invertebrate paleontology center for scientists.

Initial formation, development, and care of the California Institute of Technology invertebrate fossil collection was the work of Professors W. P. Popenoe and W. P. Woodring and their colleagues and students during the period 1927 through 1952, followed by Professor H. A. Lowenstam and his colleagues and students. The parts of the collection that chiefly represent the Cenozoic of western North America were acquired by the Museum, leaving about half the collection in the possession of the Institute where it is needed for the continuing research of Professor (now Emeritus) Lowenstam.

The University of Southern California invertebrate fossil collection was amassed under Professor W. H. Easton and his colleagues and students. It is particularly rich in Paleozoic fossils, reflecting the emphasis of Professor Easton's research on fossils of this age. The special cooperation of the Museum and the University in the field of invertebrate paleontology initiated with Professor (now Emeritus) Easton continues under his successor, Professor D. J. Bottjer. Their students are frequent users of the Museum collections and now deposit the valuable collections which they make in the course of their studies directly into the Invertebrate Paleontology Section.



Charles L. Hogue



Charles L. Hogue

Top, left:
Head of the caterpillar of the owl butterfly (Caligo).
Top, right:
The Lantern Bug (Fulgora laternaria).
Right:
Dr. Hogue and a nest of the nasute termite (Nasutitermes).
All photos taken in the forests near Iquitos, Peru.

Entomologists on the Move

The museum's entomologists were on the road, in the air, and on the water during the summer.

Charles L. Hogue, Curator of Entomology, served for the fifth consecutive year as scientific leader in charge of insects and other small jungle animals for Mildred Mathias' UCLA Extension course on Amazonian ecology. In July Hogue visited several locations on the upper Amazon and Rio Napo out of Iquitos, Peru, where he interpreted tropical insect biology to a group of 18 students. This region, with one of the richest insect faunas in the world, provides countless awe-inspiring examples of adaptation, strange habits, and natural beauty, all especially striking to first time visitors.

Prior to instructing the field course, Hogue spent two weeks in Colombia, primarily working with the Laboratorio Alexander Humboldt of the University of Antioquia in Medellín. The laboratory is conducting extensive taxonomic and ecological studies on the aquatic insects of the country, with Hogue contributing from his own work on New World tropical midges associated with waterfalls and torrential water streams. His collections and new contact with the university are providing considerable stimulus to the section's research programs in Latin America.

Assistant Curator Julian P. Donahue, the museum's lepidopterist, has been re-elected to a third 3-year term as Secretary of the Lepidopterists' Society, a worldwide group of more than 1500 members dedicated to the study of moths and butterflies. In July he flew to the Society's 34th Annual Meeting in Columbus, Ohio, to discuss current research as well as ways the museum's collections can play a more prominent role in worldwide systematic and zoogeographic studies. While there he also reviewed with amateur lepidopterists the benefits of participating in the growth of the museum's research collection.

Later, in August, Donahue organized and participated in the 30th Annual Meeting of the Society's Pacific Slope Section, held at Camp Inyo near Big Pine. Fifty-eight members from as far away as Grand Coulee, Washington and Salt Lake City, Utah gathered to study the local fauna and hear presentations on topics ranging from the natural history of the region to egg-laying and assembling behavior of Lepidoptera.

Roy R. Snelling, Curatorial Assistant, returned from an October trip to the eastern United States, mainly for the purpose of packing and transporting to the Section two large and very important scientific collections of ants. The addition of 200,000 specimens of these biologically significant insects, comprising the life's work of the late William F. Buren, plus approximately 300,000 *Pseudomyrmex* (called "fever ants," because of their potent sting) donated by Daniel H. Janzen, will considerably enlarge the museum's holdings, already the second largest and most comprehensive collection of ants in the Western Hemisphere.

Return of "The Gregorian 400"

Two TERRA readers have spotted errors in "The Gregorian 400" article (November/December 1983) that need to be corrected. Kelley L. Ross of Van Nuys noted that the British Palestine coin illustrated on page 24 does not depict the Muslim calendar date, as the caption states. The Arabic numerals show the same date as the European Arabic numerals above them.

Albert G. Wilson of Woodland Hills has pointed out that the Gregorian calendar was 12 days *ahead* of the Julian calen-

dar in 1896, not 12 days *behind* as the article states. The opening ceremonies of the Olympic Games of that year took place on March 24, according to the Julian calendar, which Greece adhered to at that time. That same day was calculated as April 5 in the United States and other nations that operated under the Gregorian system. So, if the American athletes had planned to arrive in Athens before March 24, they would have been early for the Games rather than late.

This mistake, which appears in several histories of the Olympic Games, has been traced to a statement made by an American athlete who took part in the 1896 competition. The athlete related that he and his compatriots arrived in Athens on the day before the Games commenced because of the discrepancy in the two calendars, but we know now that this was not the case.

The author of "The Gregorian 400" pleads guilty in the coin error and the perpetuation of the Olympics myth and wishes to thank our two readers for setting the record straight

Tom Sitton

TRAVEL OPPORTUNITIES FOR MUSEUM MEMBERS

The Natural History of the Galapagos Islands: A Cruising Expedition June 19th to July 3rd, 1984

In cooperation with the Natural History Museum Alliance and the Greater Los Angeles Zoo Association, UCLA Extension is presenting its tenth annual tour of the Galapagos Islands.

Explore this world-famous "living laboratory of evolution" while cruising on the *MV Santa Cruz*, the newest and finest ship available, which has been chartered exclusively for this program.

You will visit the biologically significant islands, including Tower Island. Excursions in Ecuador include a spectacular journey down the scenic Andes to Guayaquil on the coast.

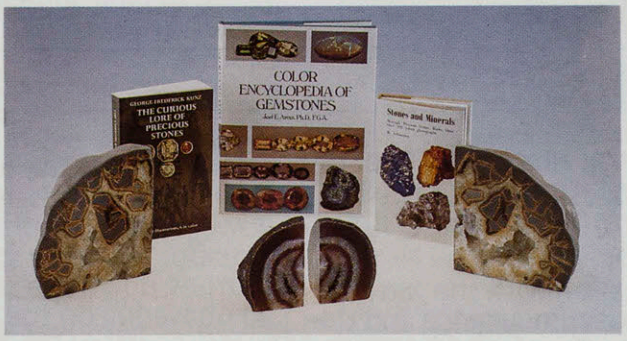
The instructors accompanying the expedition are Dr. John W. Wright, Curator of Herpetology at the Natural History Museum, and Dr. Hartmut Walter, Professor of Geography at UCLA.

For further information, contact the Natural History Museum Membership Office, (213) 744-3426.

Michael Cyr

The Museum Shops

In the BOOK SHOP... MINERAL BOOKS



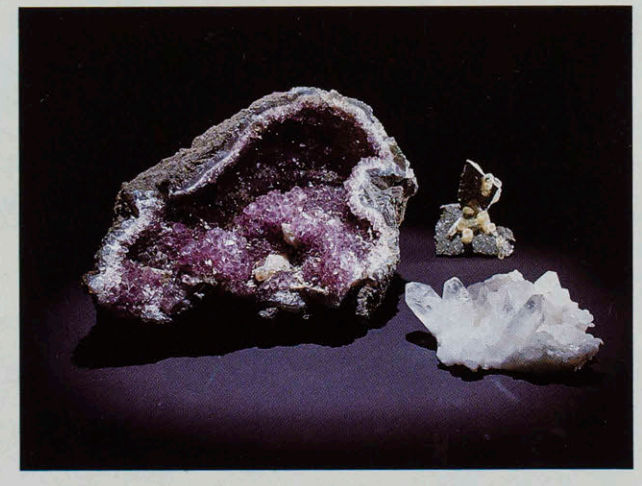
THE CURIOUS LORE OF PRECIOUS STONES provides an intriguing historical view of mankind's fascination with gems and minerals. $5.95

COLOR ENCYCLOPEDIA OF GEMS AND MINERALS is a comprehensive reference source, listing gems alphabetically according to mineral species. $37.50

STONES AND MINERALS has broad appeal because it makes possible the rapid identification of minerals, precious and semi-precious stones, rocks, ores, and fossils. $17.95

Mail and telephone (744-3434) orders accepted.

In the ETHNIC ARTS SHOP and the PAGE MUSEUM SHOP... MINERAL SPECIMENS



Spectacular mineral specimens are a wonder to observe and a joy to own. They are natural treasures that will delight and fascinate and grow in value for years to come. Choose from amethyst geodes, agate slabs, quartz crystals, and septarian bookends.

THE BOOK SHOP
Natural History Museum
900 Exposition Blvd.
Los Angeles, Calif.
(213) 744-3434

THE ETHNIC ARTS SHOP
Natural History Museum
900 Exposition Blvd.
Los Angeles, Calif.
(213) 744-3336

THE PAGE MUSEUM SHOP
George C. Page Museum
5801 Wilshire Blvd.
Los Angeles, Calif.
(213) 931-5273

Don't miss the
WEEKEND GEM SEMINAR, *March 2, 3 and 4, 1984.*
See the calendar section for details.

Natural History Museum of Los Angeles County
Exposition Park, Los Angeles, California 90007